DESIGNER'S GUIDE KNIGHT XL BOILER

KNIGHT® COMMERCIAL BOILER XL

UP TO 94.6%
THERMAL EFFICIENCY

Lochinvar®
High Efficiency Water Heaters, Boilers and Pool Heaters

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Dear Design-Build Contractor / Project Manager / Design Engineer,
At Lochinvar, we have long recognized the importance of innovation to any product or service. Those who share in this business also face the challenge of meeting constantly changing needs and energy efficiency demands.

The designer's guide you are now holding has been designed to make it more convenient for you to select the perfect Lochinvar boiler for your projects and provide correct specifications for your teams.

All information has been organized and presented in a succinct, easy-to-use manner, so you can use and share information confidently and with minimal effort.

However, it is important to remember that this guide is not intended to replace our installation manual. Installers should refer to our installation manual for specific installation instructions and more detail. This guide will make regular reference to other documents like the Installation & Operation Manual that are available on the Lochinvar website, **www.Lochinvar.com**.

We hope this manual will make your work easier and more productive. Thanks again for specifying the Lochinvar family of quality standard and custom-built water heaters and boilers.

Sincerely,

Lochinvar®
High Efficiency Water Heaters, Boilers and Pool Heaters

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At Lochinvar, we know that designing a boiler is hard work.
Designing a boiler system is no picnic either. Demands for greater efficiency and elaborate system control have made systems more complex.

This designers guide will break down the system requirements that match the Knight XL boiler to assure safe operation, highly efficient heating and long life.

There are five major elements of boiler system design:

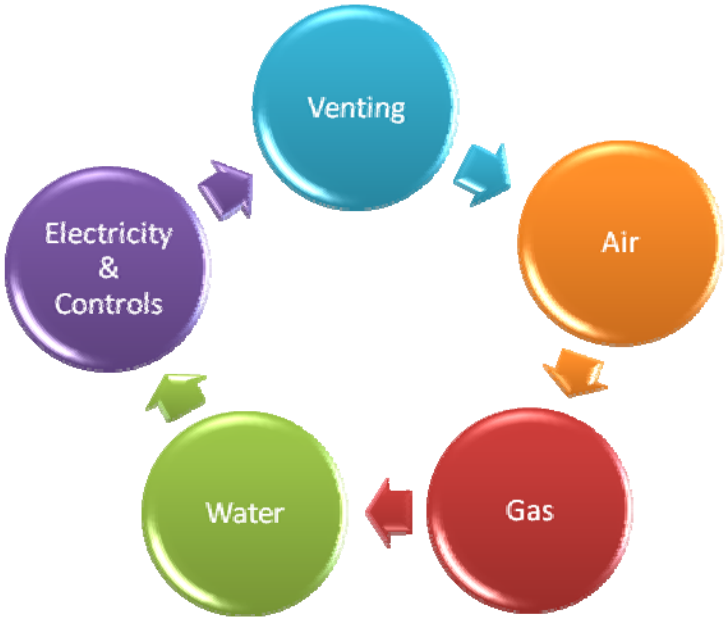
Venting
(See page 2)

Combustion Air
(See page 12)

Gas
(See page 15)

Water
(See page 17)

Electricity & Controls
(See page 23)



Plus many other important details:

Locations
(See page 29 for "Location of Unit")

Available Options
(See page 30 for "Options")

High Altitude Requirements
(See page 30 for "High Altitude Applications")

Suggested Piping Diagram
(See page 31, "Appendix Section A")

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Chapter 1 – Venting

Venting is often the most difficult design element for the installation of a gas fired appliance, but not with the Knight XL. The designs are simple and deliver ideal operation. Still, with the venting of flue products there are important rules and regulations to follow and the installation bears a responsibility for human safety.

Warning

SPILLAGE OF FLUE PRODUCTS AND CARBON MONOXIDE EMISSIONS PRODUCED BY THE COMBUSTION PROCESS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH.

Lochinvar offers nine different vent configurations on the Knight XL boiler. There are three layouts or footprints and all are Category IV venting. They are…

Direct Vent / Sidewall
- **PVC/CPVC with Vent/Air Termination Plate**
- **PVC/CPVC with Concentric Vent Kit (400-601 only)**
- **PVC/CPVC with two pipe termination**
- **Stainless Steel with two pipe termination**

Direct Vent / Vertical
- **PVC/CPVC with Concentric Vent Kit (400-601 only)**
- **PVC/CPVC with two pipe termination**
- **Stainless Steel with two pipe termination**

Rooftop Vent with Air from the Equipment Room
- **PVC/CPVC vent with Room Air**
- **Stainless Steel vent with Room Air**

Part 1
Four Important Ideas

Here are four important ideas we need to share before we look at each vent configuration.

1. Vent Material
2. Air Intake Material
3. Vent & Air Intake Lengths
4. Vent & Air Intake Diameters

VENT MATERIAL
You have three vent materials to choose from. The vent for a Knight XL can be installed with PVC, CPVC or AL29-4C Stainless Steel. Your choice.

You can choose any one of the three but we remind you to look around because certain situations require a specific material. For example, if you are going to install the Knight XL in a closet you MUST use CPVC pipe or Stainless Steel pipe. You cannot use PVC. The logical reason is, vent pipe temperatures will be higher in a tight, poorly ventilated closet.

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Another example, some local codes do not allow the use of PVC or CPVC for venting flue products. In some areas, local code demands the use of Stainless Steel vent material.

AIR INTAKE MATERIAL

With air intake material, you have a wider choice. PVC, CPVC and ABS are allowed. Steel pipe, galvanized or stainless with all joints and seams sealed gas tight. Type "B" double wall vent material with all joints and seams sealed gas tight. With horizontal applications only, you may even use Dryer Vent or Sealed Flex Duct.

Again, you can choose whatever but we remind you of several points. ABS is acceptable for the air intake pipe but not for venting. ABS has been used in the past for venting. In some areas, local codes have been passed that disallow the use of ABS for venting.

Notice the regular reference to sealing the joints and seams. Whatever air intake material is used, the piping MUST be sealed air tight or gas tight. This is also a requirement of the vent piping. But that is logical. It's a positive pressure stack carrying flue products so it must be sealed from leaks. People often wonder why we ask to seal the air intake pipe. It's to keep a balance of pressure between the air pipe and the vent pipe. A balance that helps the Knight XL breathe easier.

The use of double wall "B" Vent or insulated material for the combustion air intake pipe is recommended in cold climates to prevent the condensation of moisture.

VENT LENGTHS

The minimum length for the combustion air intake piping is 12 equivalent feet. The minimum length for the exhaust is 12 equivalent feet.

The maximum length for the combustion air intake piping is 100 equivalent feet. The maximum length for the exhaust is 100 equivalent feet.

When determining equivalent length, add 5 feet for each 90° elbow and 3 feet for each 45° elbow.

VENT & AIR INTAKE DIAMETERS

Knight XL 400 – 501 – 601 / 4" vent and 4" air intake pipe.
Knight XL 701 – 801 / 6" vent and 4" air intake pipe.

The total lengths of each pipe must be these listed diameters. Increasing or decreasing the vent or combustion air piping is not authorized.

Part 2
Vent / Air Intake Configurations

In the following pages, we will look at each vent / air configuration. For more details and installation requirements, please review the Knight XL Installation and Operation manual.

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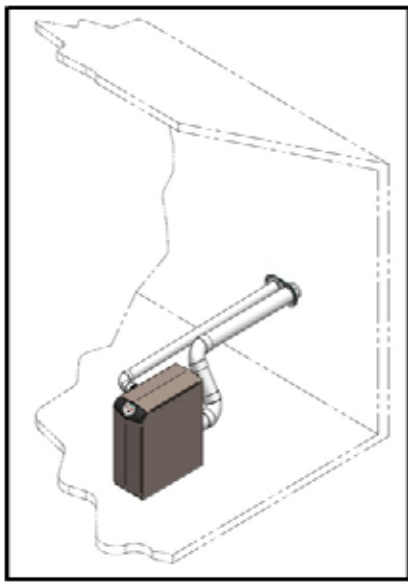
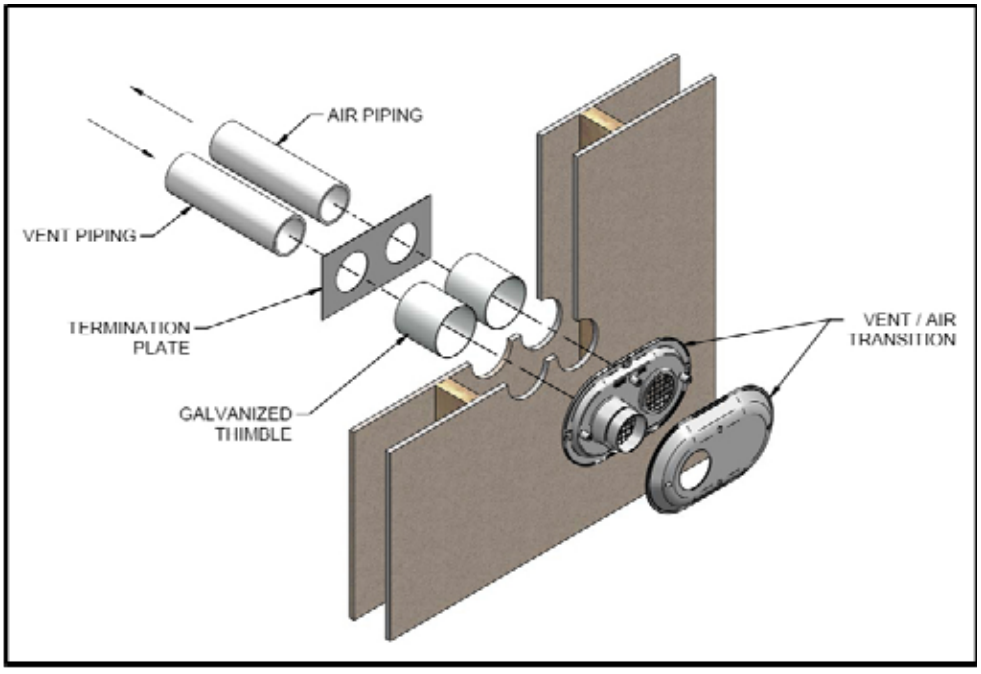
DIRECT VENT / SIDEWALL - CATEGORY IV VENTING PVC / CPVC WITH VENT/AIR TERMINATION PLATE.

The exhaust piping terminates out the sidewall. The combustion air piping terminates out the sidewall.



BULLET POINTS

- This is Category IV venting, positive pressure, condensing stack.
- All joints and seams must be sealed gastight and may not be common vented.
- The vent termination plates are provided by Lochinvar as standard equipment and all other vent material for this configuration will be obtained locally.
- Maximum distance – 100 equivalent feet of vent.
- Maximum distance – 100 equivalent feet of air intake.



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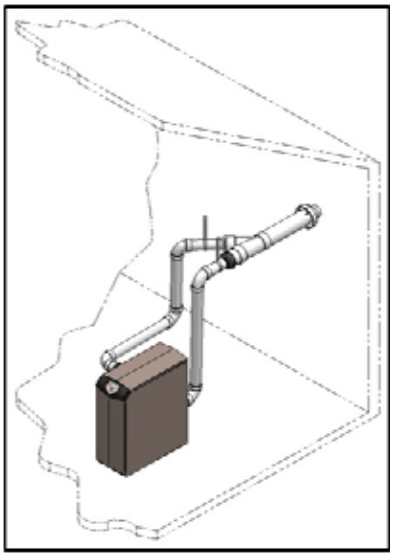
DIRECT VENT / SIDEWALL - CATEGORY IV VENTING PVC / CPVC WITH CONCENTRIC VENT KITS (399-600 ONLY).

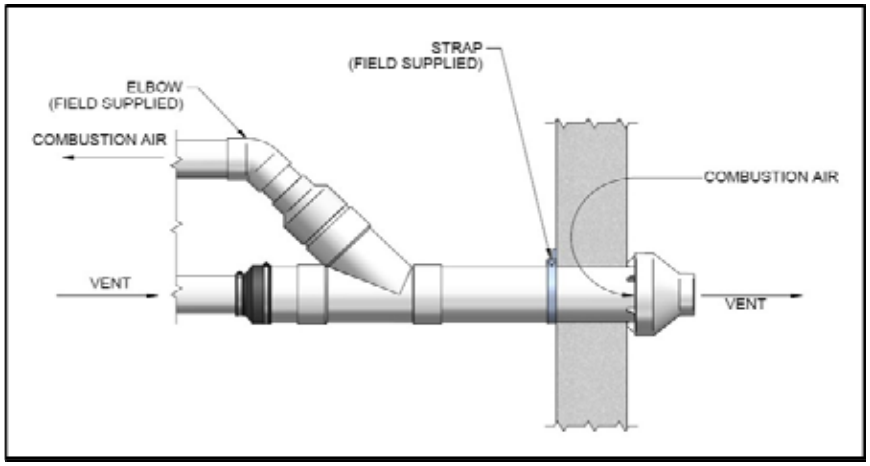
The exhaust piping terminates out the sidewall. The combustion air piping terminates out the sidewall.



BULLET POINTS

- This is Category IV venting, positive pressure, condensing stack.
- All joints and seams must be sealed gastight and may not be common vented.
- The concentric vent termination is provided by Lochinvar and all other vent material are obtained locally.
- Maximum distance – 100 equivalent feet of vent.
- Maximum distance – 100 equivalent feet of air intake.

Model	Kit Number	Equivalent vent length
KB(N,L) 400	CVK3007	5 Feet (1.5 m)
KB(N,L) 501	CVK3007	30 Feet (9 m)
KB(N,L) 601	CVK3007	30 Feet (9 m)



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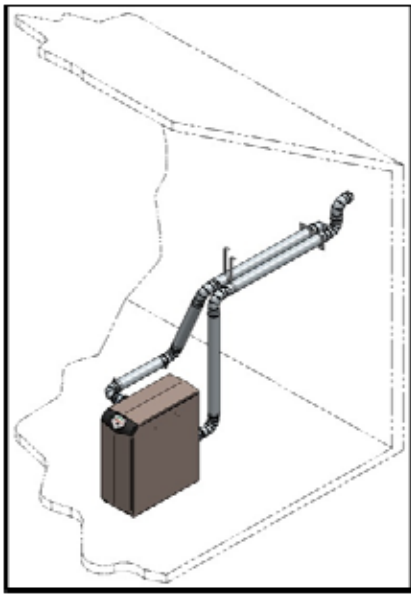
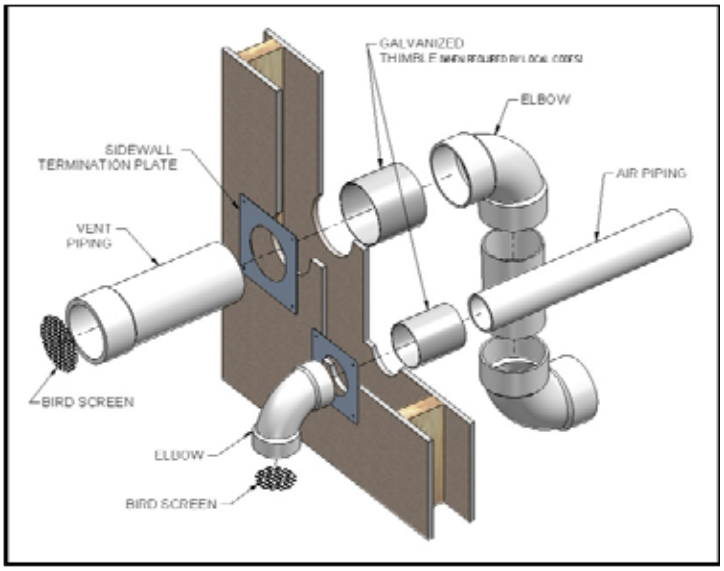
DIRECT VENT / SIDEWALL - CATEGORY IV VENTING PVC / CPVC WITH TWO PIPE TERMINATION.

The exhaust piping terminates out the sidewall. The combustion air piping terminates out the sidewall.



BULLET POINTS

- This is Category IV venting, positive pressure, condensing stack.
- All joints and seams must be sealed gastight and may not be common vented.
- All the vent material for this configuration are obtained locally, including the terminations.
- Maximum distance – 100 equivalent feet of vent.
- Maximum distance – 100 equivalent feet of air intake.



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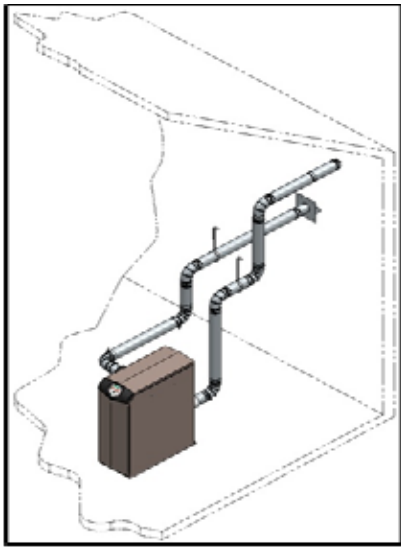
DIRECT VENT / SIDEWALL - CATEGORY IV VENTING STAINLESS STEEL WITH TWO PIPE TERMINATION.

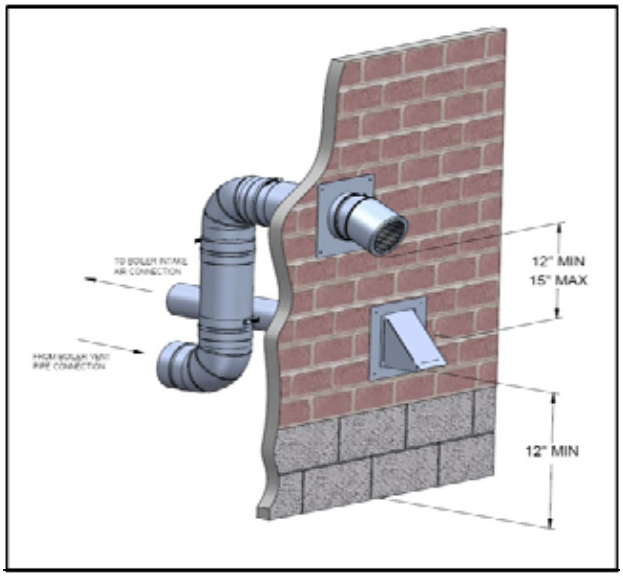
The exhaust piping terminates out the sidewall. The combustion air piping terminates out the sidewall.



BULLET POINTS

- This is Category IV venting, positive pressure, condensing stack.
- All joints and seams must be sealed gastight and may not be common vented.
- The stainless steel vent and air intake terminations are provided by Lochinvar and all other vent material for this configuration will be obtained locally.
- Maximum distance – 100 equivalent feet of vent.
- Maximum distance – 100 equivalent feet of air intake.

Model	Kit Number
KB(N,L) 400 - 601	KIT3136
KB(N,L) 701 - 801	KIT3137



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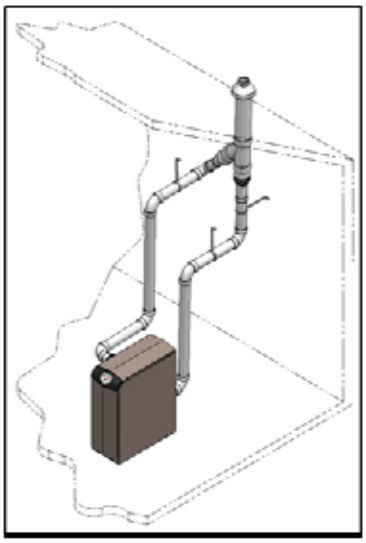
DIRECT VENT / VERTICAL - CATEGORY IV VENTING PVC / CPVC WITH CONCENTRIC VENT KIT (400-601 ONLY).

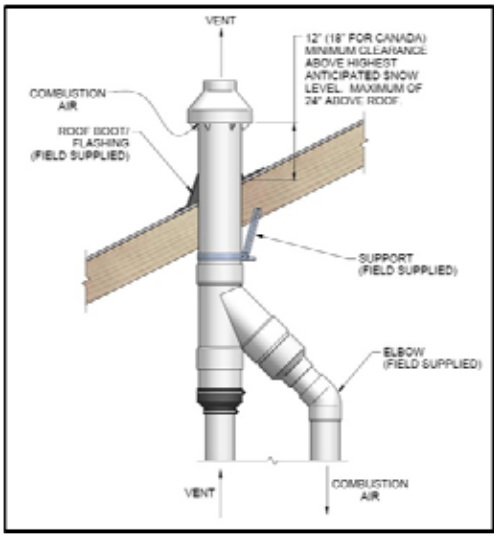
The exhaust piping terminates through the rooftop. The combustion air piping terminates through the rooftop.



BULLET POINTS

- This is Category IV venting, positive pressure, condensing stack.
- All joints and seams must be sealed gastight and may not be common vented.
- The concentric vent kit will be provided by Lochinvar. All other vent material will be obtained locally.
- Maximum distance - 100 equivalent feet of vent.
- Maximum distance - 100 equivalent feet of air intake.

Model	Kit Number	Equivalent vent length
KB(N,L) 400	CVK3007	5 Feet (1.5 m)
KB(N,L) 501	CVK3007	30 Feet (9 m)
KB(N,L) 601	CVK3007	30 Feet (9 m)


VENT
12" (18" FOR CANADA) MINIMUM CLEARANCE ABOVE HIGHEST ANTICIPATED SNOW LEVEL. MAXIMUM OF 24" ABOVE ROOF.
COMBUSTION AIR
ROOF BOOT/ FLASHING (FIELD SUPPLIED)
SUPPORT (FIELD SUPPLIED)
ELBOW (FIELD SUPPLIED)
VENT
COMBUSTION AIR

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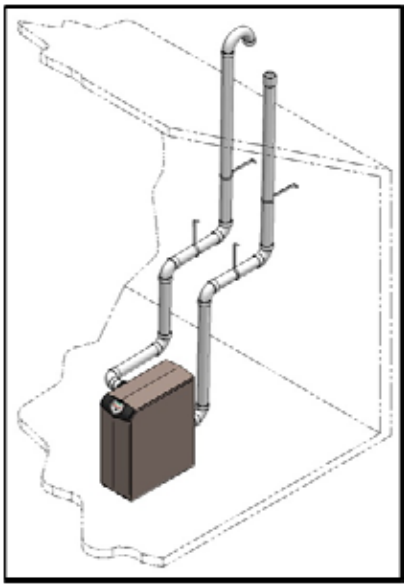
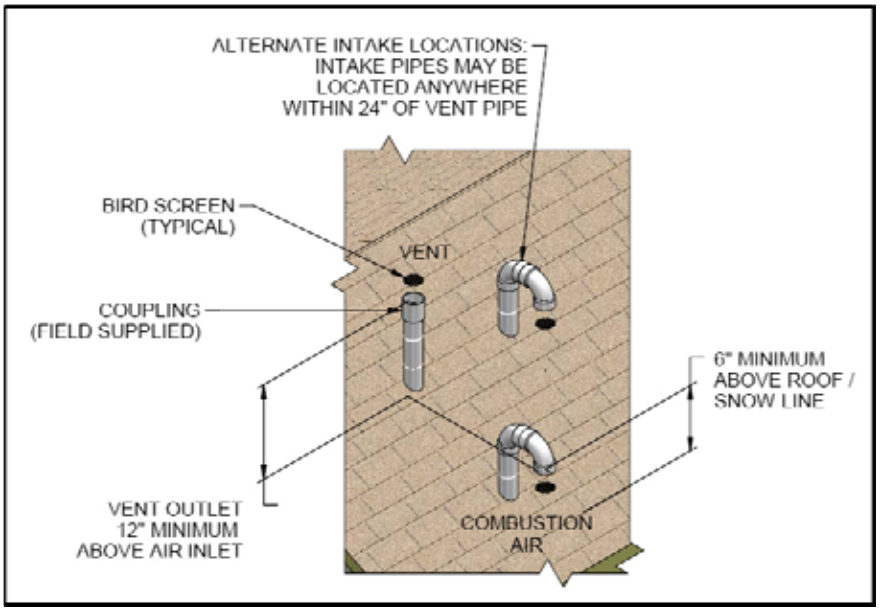
DIRECT VENT / VERTICAL - CATEGORY IV VENTING PVC / CPVC WITH TWO PIPE TERMINATION.

The exhaust piping terminates through the rooftop. The combustion air piping terminates through the rooftop.



BULLET POINTS

- This is Category IV venting, positive pressure, condensing stack.
- All joints and seams must be sealed gastight and may not be common vented.
- All the vent material for this configuration will be obtained locally, including the terminations.
- Maximum distance – 100 equivalent feet of vent.
- Maximum distance – 100 equivalent feet of air intake.



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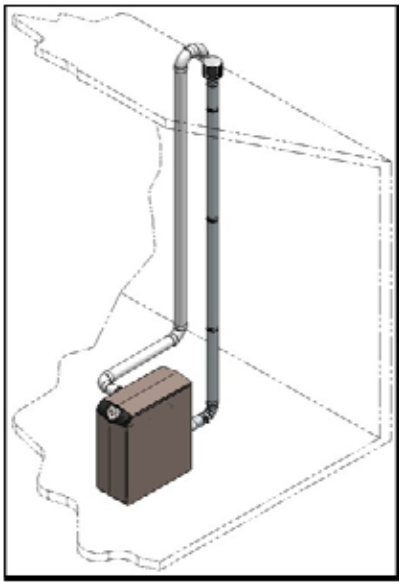
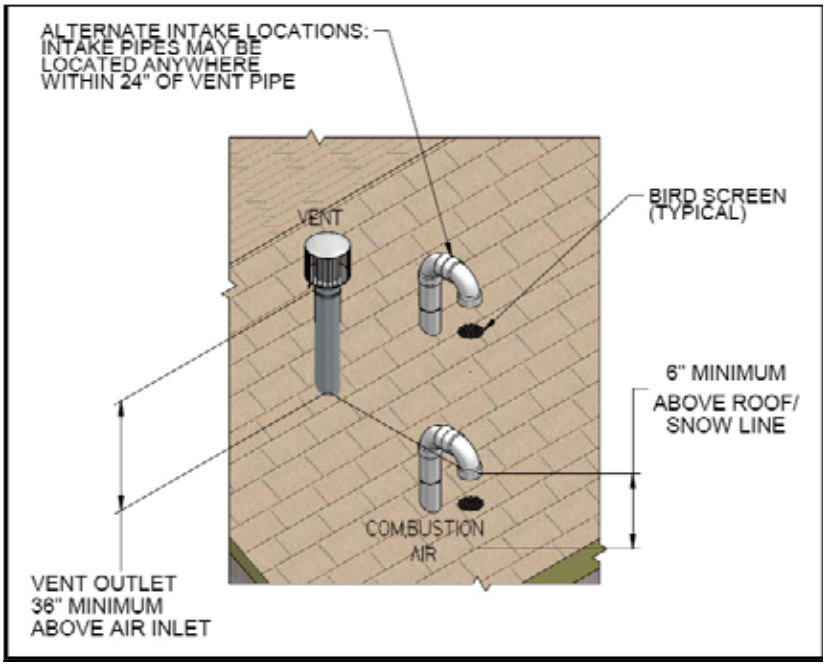
DIRECT VENT / VERTICAL - CATEGORY IV VENTING STAINLESS STEEL WITH TWO PIPE TERMINATION.

The exhaust piping terminates on the rooftop. The combustion air piping terminates through the rooftop.



BULLET POINTS

- This is Category IV venting, positive pressure, condensing stack.
- All joints and seams must be sealed gastight and may not be common vented.
- All the vent material for this configuration will be obtained locally, including the terminations.
- Maximum distance – 100 equivalent feet of vent.
- Maximum distance – 100 equivalent feet of air intake.



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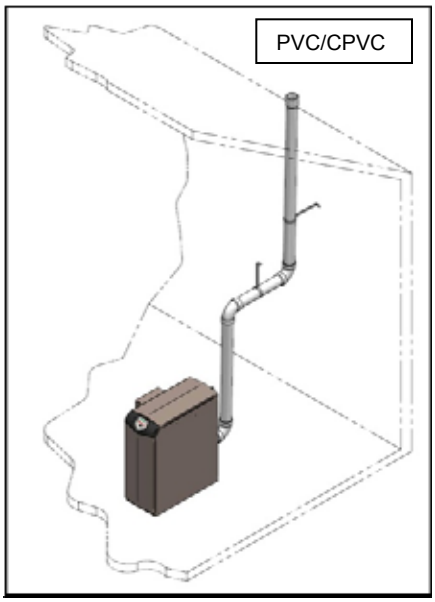
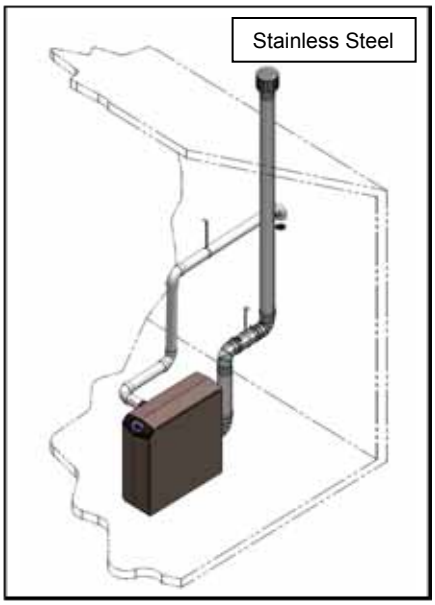
ROOFTOP VENT WITH ROOM AIR OR SIDEWALL AIR - CATEGORY IV PVC / CPVC OR STAINLESS STEEL VENT WITH AIR FROM THE EQUIPMENT ROOM OR FROM DIFFERENT PRESSURE ZONES.

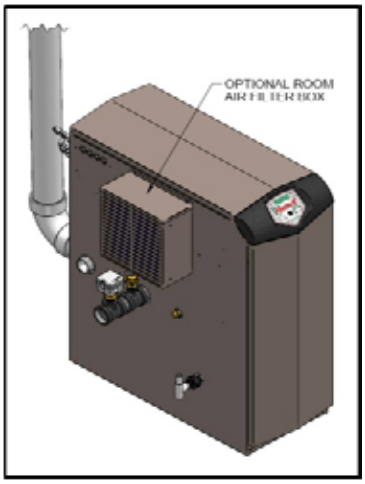
The exhaust piping terminates on the rooftop. The combustion air is drawn from the equipment room or from a sidewall termination.



BULLET POINTS

- This is Category IV venting, positive pressure, condensing stack.
- All joints and seams must be sealed gastight and may not be common vented.
- All the vent material for this configuration will be obtained locally, including the terminations.
- Maximum distance – 100 equivalent feet of vent.





Tip

IF PLANNING TO USE ROOM AIR, REMEMBER TO ORDER KIT30022, OPTIONAL AIR FILTER BOX.

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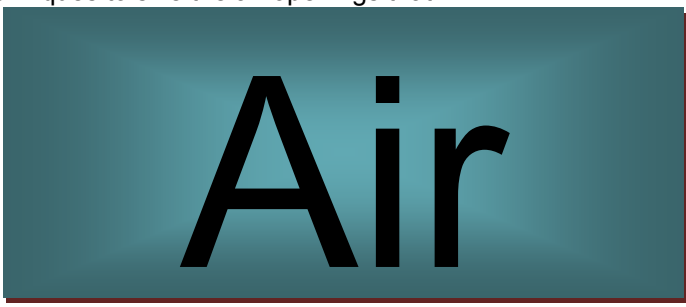
Chapter 2 – Combustion and Ventilation Air

Everybody's gotta breathe. Even boilers need air. Air seems easy enough. You stand in the equipment room and you breathe comfortably, don't you? Open a door. Open a window. This is a big room. There' s lots of air in here for the boiler. Right?

The average person inhales 400 to 500 cubic feet of air in a 24 hour period. A one million Btu/hr boiler will draw 226.38 cubic feet of air every MINUTE! A 20 by 20 by 8 foot equipment room holds 3200 cubic feet of air. That's a volume of air to last you or me over six days. A half million Btu/hr Knight XL will consume 6400 cubic feet of air in 28 minutes.

Therefore, a good, easy flow of clean air is 100% necessary for clean, efficient combustion. With the Knight XL boiler, we expect the two pipe system illustrated in Chapter 1 will be the most popular design used in the field. However, the last two offerings in the venting chapter allowed for the combustion air to be drawn into the appliance from the equipment room.

This chapter explains the methods to ventilate the equipment room to meet the combustion requirements of the Knight XL. This chapter lists several techniques to size the air openings that will deliver room air. If there are other appliances in the room requiring air, their air requirements must be including when sizing the air openings.



Provisions for combustion and ventilation air must be designed and installed in accordance with "Air for Combustion and Ventilation", of the latest edition of the National Fuel Gas Code, ANSI Z223.1, (in Canada, the latest edition of CGA Standard B149 Installation Code for Gas Burning Appliances and Equipment) or applicable provisions of the local building codes.

NEGATIVE PRESSURE IN THE EQUIPMENT ROOM

It is important to NEVER have a negative pressure on the equipment room. Exhaust fans are popular in equipment rooms to exchange the air. If the exhaust fan pulls air OUT, then a negative pressure occurs in the room. The combustion and ventilation air must be sized to supply all the equipment PLUS the air for the exhaust fan.

COMBUSTION AND VENTILATION AIR SIZING CALCULATIONS

The sizing calculations in this section are based on "Free Area". The louvers or grill used on the air openings must have a net free area equal to or greater than the value derived in the calculations. The Free Area in a louver or grill is defined as the open, unblocked area. The louvers, grills, mesh, blades, all will block a given amount of space in the louver's overall dimension. Consult the louver manufacturer for exact net free area of the louver.

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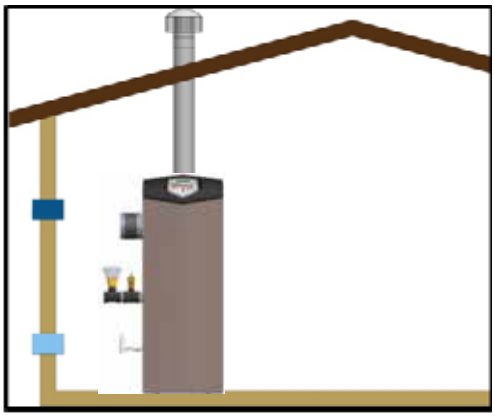
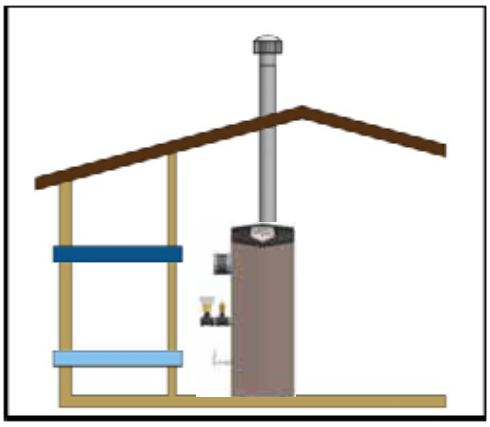
1. COMBUSTION AIR FROM OUTSIDE

If air is taken directly from outside the building with no duct, provide two permanent openings to the equipment room:
(a) Combustion air opening, with a minimum free area of one square inch per 4000 Btu/hr input (5.5 cm² per kW). This opening must be located within 12" (30 cm) of the bottom of the enclosure.
(b) Ventilation air opening, with a minimum free area of one square inch per 4000 Btu/hr input (5.5 cm² per kW). This opening must be located within 12" (30 cm) of the top of the enclosure.

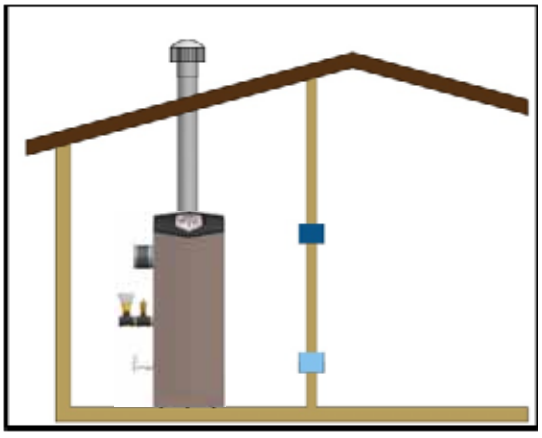




2. COMBUSTION AIR THROUGH DUCTS

If combustion and ventilation air is taken from the outdoors using a duct to deliver the air to the equipment room, each of the two openings should be sized based on a minimum free area of one square inch per 2000 Btu/hr (11 cm² per kW) of input.
The combustion air duct must be located within 12" (30 cm) of the bottom of the enclosure and the ventilation duct must be located must be located within 12" (30 cm) of the top of the enclosure.

3. COMBUSTION AIR FROM INTERIOR SPACE
If air is taken from another interior space, each of the two openings specified above should have a net free area of one square inch for each 1000 Btu/hr (22 cm² per kW) of input, but not less than 100 square inches (645 cm²).
The combustion air opening must be located within 12" (30 cm) of the bottom of the enclosure and the ventilation opening must be located must be located within 12" (30 cm) of the top of the enclosure



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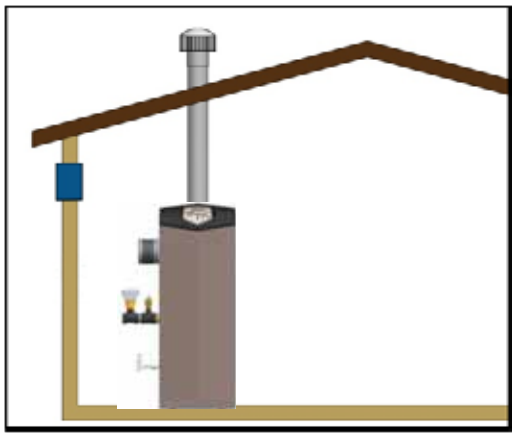


4. DIRECT OUTSIDE AIR, SINGLE OPENING

If a single combustion air opening is provided to bring combustion air in directly from the outdoors, the opening must be sized based on a minimum free area of one square inch per 3000 Btu/hr (7 cm² per kW). This opening must be located within 12" (30 cm) of the top of the enclosure.

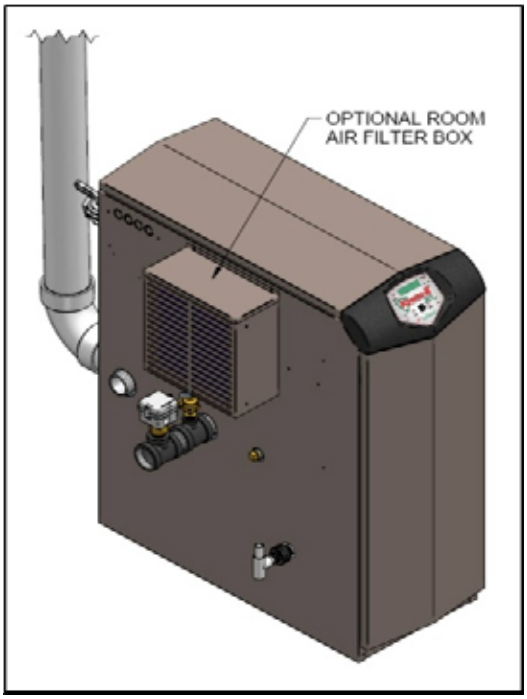
Caution

THE COMBUSTION AIR MUST BE FREE OF ANY CONTAMINANTS OR CHEMICAL FUMES. SALTS, REFRIGERANTS AND SOLVENTS INTRODUCED INTO THE COMBUSTION PROCESS WILL RESULT IN THE FORMATION OF CORROSIVE ACIDS THAT WILL DAMAGE THE APPLIANCE AND THE VENT.

COMBUSTION AIR FILTER

The Knight XL has an optional air filter box. Located on the left side over the combustion air inlet, the air filter is installed to help ensure clean air is used for the combustion process. The optional air filter box kit is part number KIT40002.

The filter size is 12" x 12" x 1" (40.6 cm x 30.4 cm x 2.5 cm). You can find these commercially available filters at any home center or plumbing supply store.



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Chapter 3 – Gas Supply

Lochinvar products are designed with the concept of flame control. We develop combustion systems that tightly control the flow of air and gas to deliver a clean and efficient burn. In Chapters 1 and 2, we showed the various methods to deliver an ample quantity of air to the appliance. In Chapter 3, we discuss delivering a steady and reliable supply of gas to the appliance.

The key to the gas supply is sizing the gas line properly. The Knight XL will require less than a half a pound of pressure. The following Sizing Chart is based on less than ½ pound of pressure or less than 14 inches of pressure. The table is derived from the ANSI Z223.1, the National Fuel Gas Code.

Simply calculate the total linear feet of straight gas pipe. Figure each elbow as equal to five straight feet of pipe. Working down the column that matches your pipe length, find the value GREATER THAN the total Btu/hr input of the boiler or boilers. This will identify the minimum nominal iron pipe size.

GAS PIPE SIZING CHART

Nominal Iron Pipe Size	Length of Pipe in Straight Feet													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
1"	697	477	384	328	292	267	246	256	210	200	179	164	149	138
1 1/4"	1,400	974	789	677	595	543	502	472	441	410	369	333	308	287
1 1/2"	2,150	1,500	1,210	1,020	923	830	769	707	666	636	564	513	472	441
2"	4,100	2,820	2,260	1,950	1,720	1,560	1,440	1,330	1,250	1,180	1,100	974	871	820
2 1/2"	6,460	4,460	3,610	3,100	2,720	2,460	2,310	2,100	2,000	1,900	1,700	1,540	1,400	1,300
3"	11,200	7,900	6,400	5,400	4,870	4,410	4,000	3,800	3,540	3,300	3,000	2,720	2,500	2,340
4"	23,500	16,100	13,100	11,100	10,000	9,000	8,300	7,690	7,380	6,870	6,150	5,640	5,130	4,720

The Knight XL features a Negative-Regulation or Neg-Reg gas combustion system. The gas is introduced upstream of the combustion blower. As the blower draws air in, the negative pressure on the inlet of the blower pulls the gas from the gas valve. The gas/air mixture is pushed through the blower into the burner. The gas/air mixture filters through the micro-metal burner mesh and is ignited by the Spark Igniter.

On full fire, a crisp blue flame rises off the surface of the burner. As demand decreases, the operating control reduces the blower speed. The flame is reduced and it touches the burner surface. The micro-metal fiber burner material is designed to burn infra-red safely without being damaged by direct contact of the flame. Even at this reduced Btu/hr input, the gas/air mixture is balanced to provide clean, efficient combustion.

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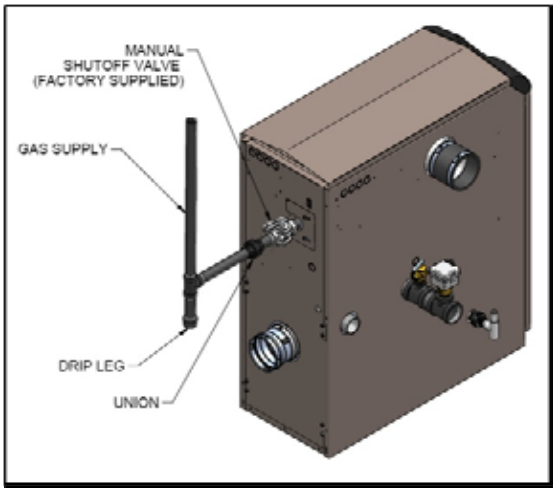
The Knight XL Boiler 400-801 has a 1" gas pipe connection. Logically, the gas pipe size from the meter to the boiler may be larger than the appliance connection.



The table below lists the Minimum and Maximum Inlet Gas Pressures.

INLET GAS PRESSURE				
Model	NATURAL GAS		L.P. GAS	
Number	Max. w.c.	Min. w.c.	Max. w.c.	Min. w.c.
Knight XL 400-801	14"	4"	13"	8"

L.P. GAS MODELS

Knight XL models are typically shipped ready to fire on natural gas. If set to natural gas, the Knight XL boiler may be easily field converted to L.P. gas by either an orifice change or a gas valve pressure adjustment. See the Knight XL Installation and Operation manual for details.

GAS PRESSURE REGULATORS

Lochinvar recommends the use of "Lock-Up Type" gas pressure regulators on the system gas supply. A Lock-Up Type gas pressure regulator features a seat that seals the regulator orifice when the appliance is off and there is no demand for gas. The seat will seal against the orifice, shutting off the flow of gas to the appliance.

A standard regulator without a Lock-Up mechanism will allow the system pressure to reach the boiler when it is off. The system pressure can "creep up" pressing against the appliance gas train with excessive system pressures. This can damage the components in the gas train.

Important

HIGH PRESSURE GAS REGULATORS MUST BE THE LOCK-UP VARIETY AND MUST BE INSTALLED NOT LESS THAN 10 EQUIVALENT FEET FROM THE BOILER TO PROVIDE AN ADEQUATE VOLUME OF GAS FOR SMOOTH IGNITION.

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Chapter 4 – Water

We are no longer designing the gigantic, lumbering, gravity-feed boiler systems of our grandfathers. Buildings are bigger and more complex. Energy efficiency and "green" building demands have requirements for precise flow, for targeted temperatures, for low water volume and more. They also demand a water piping system that will not only meet the demands of the building but also not damage the boiler.

IMPORTANT BULLET POINTS FOR WATER PIPING

1. **Water Connections**
   Knight 400-501 models have 1 ½" NPT and Knight 601-801 models have 2" NPT threaded pipe inlet and outlet connections. Installed piping to the boiler must match the 1 ½" or 2" diameter, minimum.
2. **Working Pressure**
   The boiler should not be operated at less than 12 PSIG.
3. **Minimum & Maximum Water Temperatures**
   The minimum inlet water temperature entering the boiler is 0°F (-18°C) with untreaded water, less with a glycol mix.
   The maximum outlet water temperature leaving the boiler is 195°F (91°C).
4. **Flow Rate**
   The boiler works best with a constant flow rate through the heat exchanger. However, recent changes to the SMART SYSTEM control allow the use of variable flow pumps.
5. **Unions and Ball Valves**
   The water piping to the boiler should have unions and ball valves at the inlet and outlet of the boiler to isolate the boiler for service. Use only full port ball valves.

There are three major concepts to consider when designing the near boiler piping system. They are…

WATER FLOW
WATER TEMPERATURE
WATER VOLUME

Basically, a boiler or bank of boilers has a given range of operation under these three concepts. A boiler has a water flow rate range. A boiler has a water temperature range. A boiler has a water volume range. If you design a system that lets the boiler operate within its comfort zone, it lives a long and prosperous life. If the system forces the boiler to operate outside any one of the three comfort zones; the boiler suffers.

WATER FLOW

There are an infinite variety of system piping which will vary based on the system's components and operational design. Our focus and the focus of this guide is to provide the Knight XL boiler with the flow rate that will allow it to operate at maximum efficiency without damage. To that end, Lochinvar requires Primary / Secondary piping.

Typically, system flow rates and boiler flow rates need to be controlled separately, that's why a Primary / Secondary piping loop is best. The Primary Loop, hereafter referred to as the "System Loop" flows water around the building. The Secondary Loop, hereafter referred to as the "Boiler Loop" branches off the system loop to flow water into and out of the boiler.

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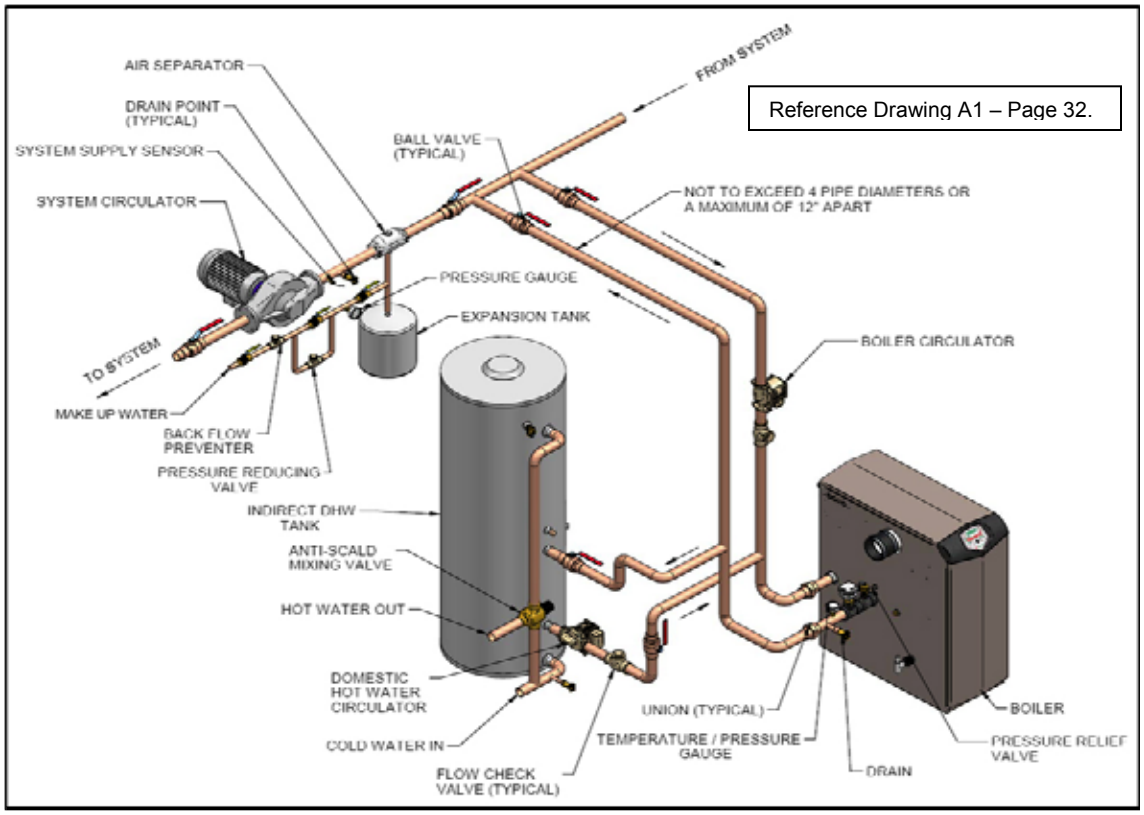
The purpose of System / Boiler Loop piping is to separate or "decouple" the system flow rate from the boiler flow rate.



Reference Drawing A1 – Page 32.

The System Loop will have its own dedicated "System Circulator". This circulator will circulate throughout the building. The Boiler Loop will have its own dedicated "Boiler Circulator". This circulator will pull from the system to flow into and out of the boiler. The Boiler circulator is field supplied and must be sized for the head loss of the boiler and related pipe and fittings in the Boiler Loop only.

BOILER CIRCULATOR REQUIREMENTS

Again, there will be a minimum of two pumps in a System / Boiler Loop. Both pumps are provided by the installer. The boiler pump must be sized to provide adequate flow through the boiler and the Boiler Loop piping. A Boiler Temperature Rise Chart is provided to assist in proper pump selection. This table provides GPM and boiler head-loss at various temperature rises for each model based on Btu/hr input. Pipe diameter and length are critical to ensure proper flow through the boiler. The values listed on the table are based on 20 feet of piping, 4 – 90° elbows and 2 – full port ball valves.

CIRCULATOR PUMP SPECIFICATIONS

1. Maximum operating pressure for the pump must exceed system operating pressure.
2. Maximum water temperature should not exceed the nameplate rating.
3. Cast iron circulators may be used in closed loop systems.

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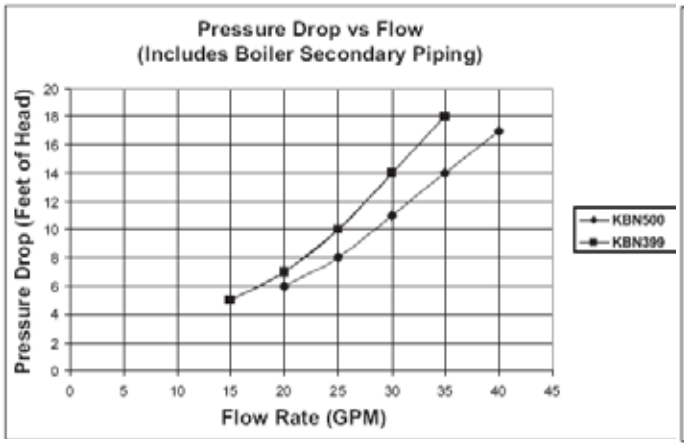
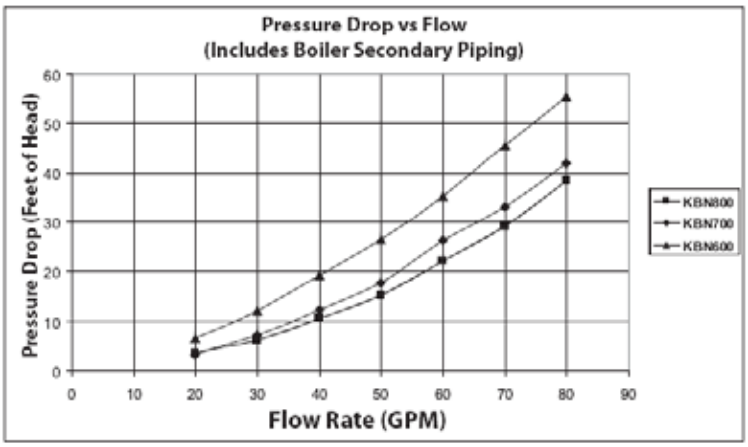
BOILER TEMPERATURE RISE CHART									
Model Number	Minimum Pipe Size	20°FΔT		25°FΔT		30°FΔT		35°FΔT	
		GPM	Ft/hd	GPM	Ft/hd	GPM	Ft/hd	GPM	Ft/hd
KB(N,L) 400	1 1/2"	37	21	30	14	26	11	21	8
KB(N,L) 501	1 1/2"	46	23	37	16	32	13	26	10
KB(N,L) 601	2"	55	31	44	22	38	18	32	13
KB(N,L) 701	2"	65	30	52	20	45	16	37	11
KB(N,L) 801	2"	74	33	60	23	51	18	42	12





WATER FLOW

We have one note of caution for you regarding water flow. That is this.

Is the minimum planned flow rate for the system loop below that of the planned flow rate through the boiler?

In a Primary / Secondary Piping System, the lowest potential System Loop Flow Rate MUST be 25% greater than the Boiler Loop Flow Rate.

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LOW SYSTEM FLOW RATE

The use of System / Boiler Loop piping is used to separate the higher system flow rate from the lower boiler flow rate. But what about low system water flow? Doesn't the System / Boiler Loop piping protect the boiler during low system flow? Not if the system flow rate drops below the flow rate chosen for the Boiler loop.

Here's what happens. The boiler flow rate will backfeed down the System line and recirculate taking the path of least resistance. This means the boiler is recirculating already heated water in a very small volume.

We mention this because this dynamic is occurring more and more often as we see Variable Speed pumps and 3-way valves used in System Loop piping. The principle of the variable speed pump or 3-way valve is to increase or decrease flow rates through the System Loop as building demand changes. Good for the system but not always so good for the boiler. If the system's flow rate is not 25% greater than the boiler flow rate, it is highly recommend you use a Buffer tank.

BUFFER TANK

A buffer tank solves this problem. The buffer tank adds water volume at the point where the System Loop and the Boiler Loop meet. Classic System / Boiler Loop piping isolates the flow rates well but a Buffer tank will isolate the flow rates completely and add water volume to provide a strong "decoupler" for the boiler.

Refer to Lochinvar's "Buffer Tank / Air Eliminator" product brochure for a tank selection chart or visit the Lochinvar website for a fully automated tank sizing program.

WATER TEMPERATURE

Here are two easy questions.

What is the minimum return water temperature from the System Loop?
What is the maximum outlet water temperature needed for the System Loop?

The minimum return water temperature to the Knight XL boiler is 50°F (10°C).
The maximum outlet water temperature from the Knight XL boiler is 195°F (91°C).

Reason we ask? The Knight XL is a condensing boiler. And like all condensing boilers, you get your highest thermal efficiency with a low return water temperature. With non-condensing appliances, the minimum water temperature is a warning of detrimental operation. With a condensing boiler, the minimum water temperature is an invitation to high efficiency.

A condensing boiler extracts heat from two sources, the flame and the flue products. One portion of the heat exchanger is in direct contact with the flame and will transfer its heat into the water. After combustion is completed the flue products make their way out of the combustion chamber. On the way out, the flue products will pass over a second coil and the heat from the flue products is transferred into the water in the second coil. The cooler the water, the more heat is transferred.

Therefore, cooler inlet water means higher efficiency. See the chart on the following page. With low return water temperatures, the efficiency rating is high, up to 98%. As the return water temperature rises, the heat transfer from the flue products is reduced and efficiency drops.

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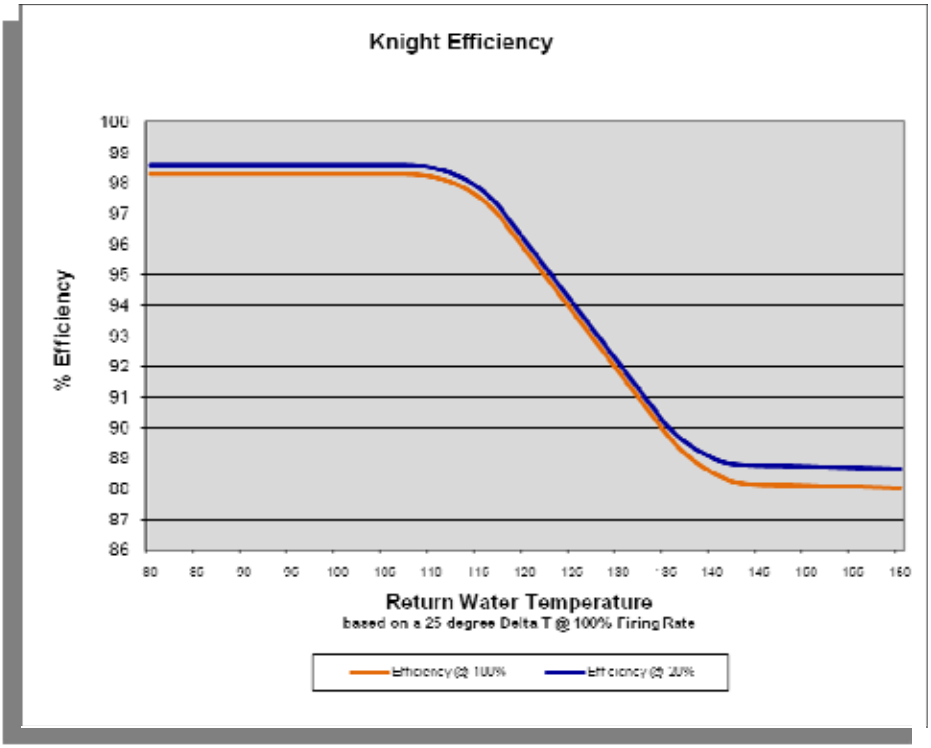

The maximum water temperature is always a warning. Do not exceed the maximum outlet water temperature. Again the maximum allowable outlet water temperature is 195°F. By exceeding this value, the heat exchanger coils may overheat and be damaged.

WATER VOLUME

The idea is to keep an amount of water in the system to support the heating capacity of the boiler during the lowest possible demand.

What is the minimum Btu/hr system demand?

The minimum system demand must be GREATER than the minimum boiler output.

The standard model Knight XL "M9" boiler has a 5:1 Turndown ratio. Or a minimum Btu/hr output rate down to 20% of the heater's total output rate. That will increase our chances of the boiler's Btu/hr output rate being below the system demand.

Example:
Imagine an installation consisting of three air handlers with 400,000 Btu/hr rated heating coils for a total demand of 1,200,000 Btu/hr system demand. The system is heated by two Knight XL 700 boilers for a total input of 1,400,000 Btu/hr and total output of up to 1,176,000 Btu/hr. Each boiler is the standard "M9" model that fires at 5:1 Turndown.

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On a very cold winter day, all three air handlers will call for heat and the two Knight XL will fire at 100% input rate to meet the demand. On a comparatively cool autumn day, only one 400,000 Btu/hr air handler might be calling for heat. The boilers, connected together with their Smart System controls will fire only one boiler at its reduced input and output rate. The minimum 20% input rate of a single Knight XL 701 is 140,000 Btu/hr with an output of up to 137,200 Btu/hr. Well below the 400,000 Btu/hr minimum system demand. The Knight XL 701 will actually fire closer to 63% of its potential modulation rate to meet this minimum system demand.

The following table shows the maximum and minimum input and output rates for every Knight XL with all of the available Firing Codes. Calculate the minimum load of your design to make sure the system demand or system volume will support minimum boiler output rate.

Model Number	Maximum Input Rate	Maximum Output Rate	Minimum Input Rate	Minimum Output Rate
KB(N,L) 400	399,999	391,999	80,000	78,400
KB(N,L) 501	500,000	490,000	100,000	98,000
KB(N,L) 601	600,000	588,000	120,000	117,600
KB(N,L) 701	700,000	686,000	140,000	137,200
KB(N,L) 801	800,000	784,000	160,000	156,800

If the minimum Btu/hr system demand is SMALLER than the boiler's minimum Btu/hr output then there may be insufficient water volume. If that is the case, then a Buffer tank is your solution.

BUFFER TANK
The buffer tank adds water volume to the system providing the volume needed to support the minimum output rate of the boiler if the minimum system load can't.

Refer to Lochinvar's "Buffer Tank / Air Eliminator" product brochure for a tank selection chart or visit the Lochinvar website for a fully automated tank sizing program.

INDIRECT DOMESTIC WATER HEATING WITH THE BOILER SYSTEM
The Knight XL boiler system can be configured to provide Domestic Hot Water with the addition of Lochinvar's Hot Water Generator Systems. The Hot Water Generator is a storage tank fitted with a heating coil. A sufficiently sized boiler will heat both the potable hot water demand and provide source water for the hydronic heating systems. Hot Water Generator Systems use the boiler water as an energy source and can provide high recovery rates, making them an economical water heating system.

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Chapter 5 – Electrical & Controls

The first idea for this chapter is supplying power to the boiler. A 120 VAC, 15 Amp, 1 ph, 60 Hz circuit is required for operation of the boiler.

The boiler, when installed, must be electrically grounded in accordance with the requirements of the authority having jurisdiction, or in the absence of such requirements, with the latest edition of the National Electrical Code ANSI/NFPA No. 70. When the unit is installed in Canada, it must conform to the CAE C22.1, Canadian Electrical Code, Part I and/or local Electrical Codes.

1. All wiring between the appliance and field installed devices shall be made with type T wire [63°F (35°C) rise].
2. All voltage wire exterior to the appliance must be enclosed in approved conduit or approved metal clad cable.
3. The appliance must be provided with proper overload protection.

AMP DRAW DATA			
Btu/Hr Input	Blowers & Controls	Pump FLA	Total Amps 120 VAC
KB(N,L) 400	6.7	8.8	15.5
KB(N,L) 501	6.7	8.8	15.5
KB(N,L) 601	6.7	8.8	15.5
KB(N,L) 701	6.7	8.8	15.5
KB(N,L) 801	6.7	8.8	15.5

Electricity & Controls

SMART SYSTEM CONTROLS

The Knight XL features the Smart System control. The Smart System control is designed to operate all the various elements of a hydronic heating system plus Domestic Hot Water. The Smart System control can operate the boiler pump, the system pump and the DHW pump. It has outdoor reset as standard equipment. But its best feature is Cascade, the organized control of up to eight separate boilers.

The Smart System control is designed to provide many of the operating features of a remote Building Management System thereby eliminating one more expensive component in your system design.

BUILDING MANANGEMENT SYSTEM CONTROL

For systems with more than eight Knight XL boilers or for systems with existing Building Management Systems, the Knight XL boiler is programmed to operate via a remote signal. A 0-10 Vdc input signal will control the boilers. The signal can be programmed to call the boilers to fire on a range of modulation or on a temperature range.

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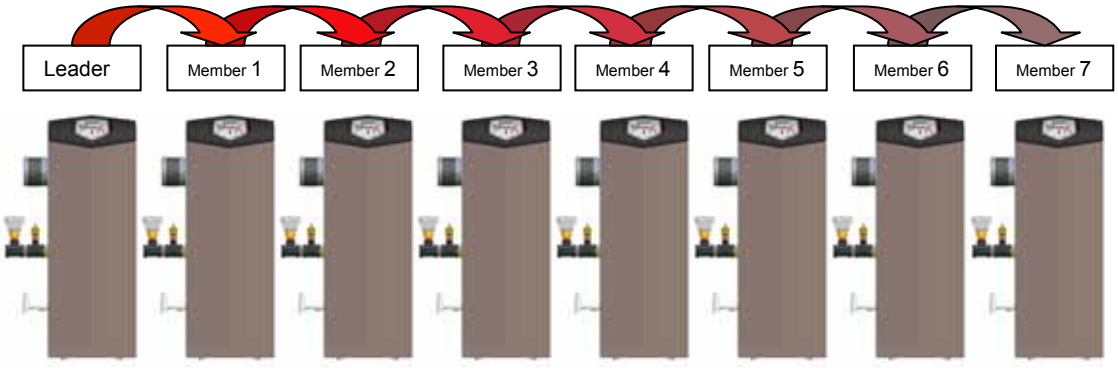
CASCADE
The Cascade feature in the Smart System control will operate up to eight boilers. Connected with 2-wire Daisy chain, any one boiler in the group is chosen as the Leader. The other boilers operate as Members. The Leader boiler makes the decision on which boiler is firing and at what rate to meet the demand.

Each day, a different boiler is assigned the role as first in the firing sequence. This built-in "Lead-Lag" feature distributes even usage over the life of the boilers. The Cascade function also operates with Outdoor Reset to increase system temperature as the outside temperature decreases.

Built-in Cascade of up to eight boilers



HIGH VOLTAGE TERMINAL STRIP AND PUMP CONTROL
If the Smart System control is going to control up to eight boilers with Cascade or operate from a BMS signal, it is only reasonable for the Smart System control to operate the circulator pumps. All three are wired through the High Voltage Terminal strip. All three pumps are field supplied. The terminal strip is rated for 120 volt, 1.5 HP or 240, volt 3 HP pumps or 30 amps maximum. For larger horse power pumps, plan to insert a switching relay or contactor to decouple the pump from the terminal strip contacts.

Boiler Pump Control
The Smart System control will activate and deactivate the pump for each System Heating call for heat. Intermittent pump operation. 30 second pump delay (programmable range - 0 minutes to 40 minutes).

System Pump Control
The Smart System control will activate and deactivate the pump for each System Heating call for heat. Intermittent pump operation. 30 second pump delay (programmable range - 0 minutes to 40 minutes).

DHW Pump Control
The Smart System control will activate and deactivate the pump for each DHW call for heat. Intermittent pump operation. 30 second pump delay (programmable range - 0 minutes to 40 minutes).

Alarm on Any Failure Contacts
Should the Smart System control detect a fault, it will send an alarm signal through these dry contacts to a remote control board or activate an alarm bell.

Run Time Contacts
The Smart System control will "make" these dry contacts for the duration of the Main Burner.

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LOW VOLTAGE TERMINAL BOARD

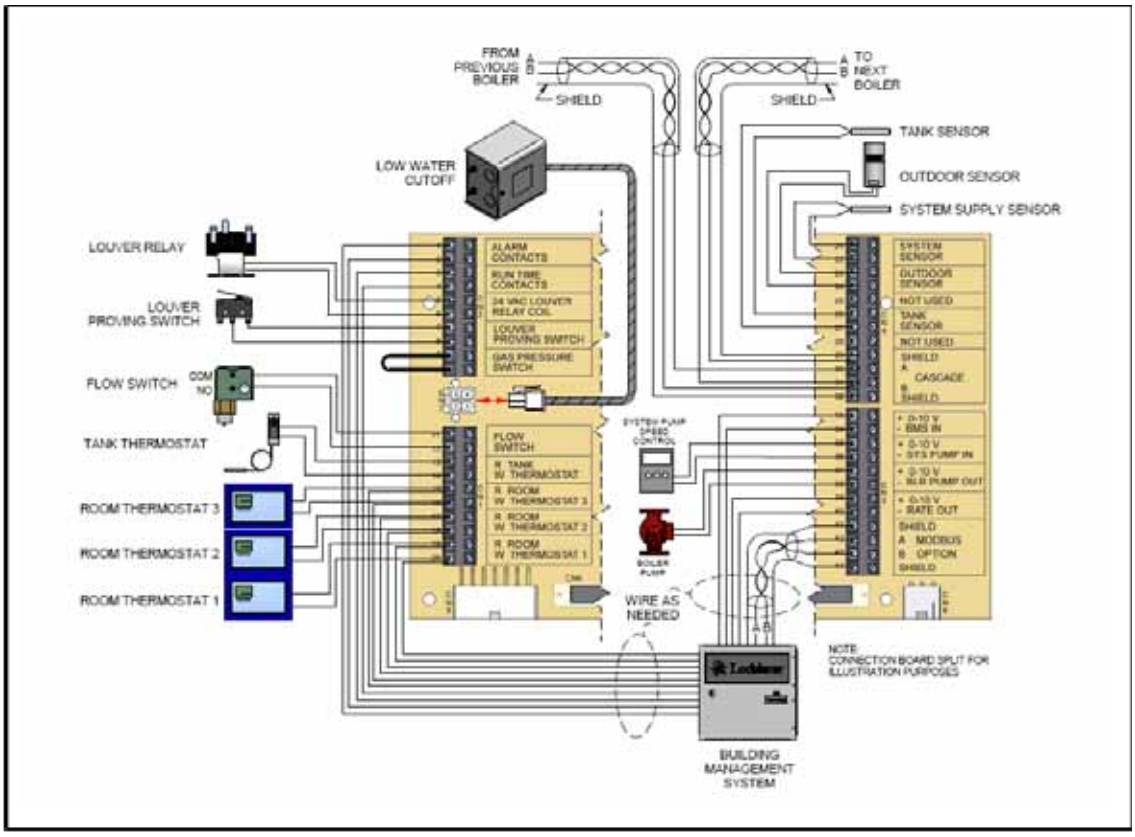
Every Knight XL is equipped with a Low Voltage Terminal Board for a variety of other field connections and control features.

Remote Enable / Disable

Wired through the Low Voltage Terminal Strip, the Smart System control can be activated by a remote thermostat or controlled with an enable / disable signal.

DHW Mode via Sensor or Thermostat

The Smart System control will operate the DHW based on a signal from a tank sensor with a resistance signal or a tank thermostat with an enable / disable signal.



Cascade

Previously noted, up to eight boilers can be connected to one another and programmed for sequenced operation, including Domestic Hot Water.

BMS Control with 0-10 vdc Input

The Smart System control can be controlled by a Building Management System with a 0-10 Vdc signal. The signal can control either the setpoint or the modulation directly. It can control a single boiler but cannot control the Cascade of multiple boilers.

DHW Tank Sensor

A sensor mounted in the Domestic Water Storage tank. The Smart System will operate the DHW from this sensor.

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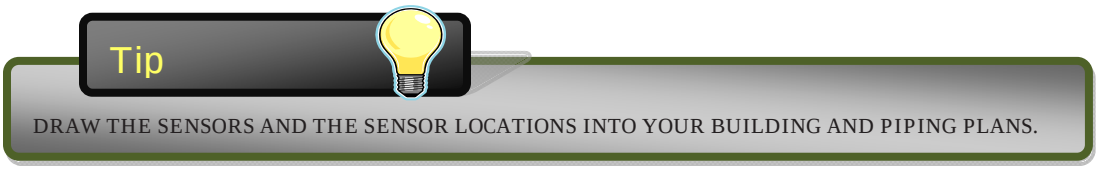
System Supply Sensor

A sensor to be mounted in the supply line of the primary system loop. When the Smart System is programmed to operate off the outlet sensor (default setting), and the system supply sensor is connected, it will control the firing rate based on this sensor. This sensor should always be installed, even when inlet temperature control is programmed for control.

Outdoor Air Reset with Outdoor Sensor

A sensor mounted outside the building. The Smart System control will adjust system temperature based on this sensor.



SMART SYSTEM OPERATIONAL FEATURES

The following is a list of just a few of the many other operational features built-in to the Smart System control. For the complete list of features with more detailed explanations plus programming parameters, refer to the Installation & Operation Manual, the Service Manual or the User Manual.

Clock

The Smart System has a clock for date and time. This must be set for record keeping and night setback functions.

DHW Priority

On a DHW call for heat, the Smart System control will interrupt a Space Heating call for heat, switching off the boiler pump and turning on the DHW pump.

Freeze Protection

The Smart System control automatically monitors the water temperatures and will operate the pump and if necessary, fire the appliance to protect the heat exchanger from freezing.

Anti-Cycling

The Smart System control will monitor burn cycles and force a minimum off time to reduce short cycling.

Night Setback

The Smart System will reduce the Space Heating or DHW setpoints during periods where the building is unoccupied. This is a programmable parameter.

Service Reminder

The Smart System control can display a reminder to the customer that it is time for a service call. This time frame is a programmable parameter.

AND MORE

Open / Shorted Sensor Detection
Fan Speed Low & Fan Speed High
Flame Current Support
Flue Temperature Limiting
Outlet Temperature Limiting
DHW versus SH Cycling
Low Voltage Blocking
Monitoring of Safety Devices
Ramp Delay
Run Time and Cycle Count
Temperature Rise Limiting
Gradient Limiting
High Limit Operation
Low Water Cutoff Protection

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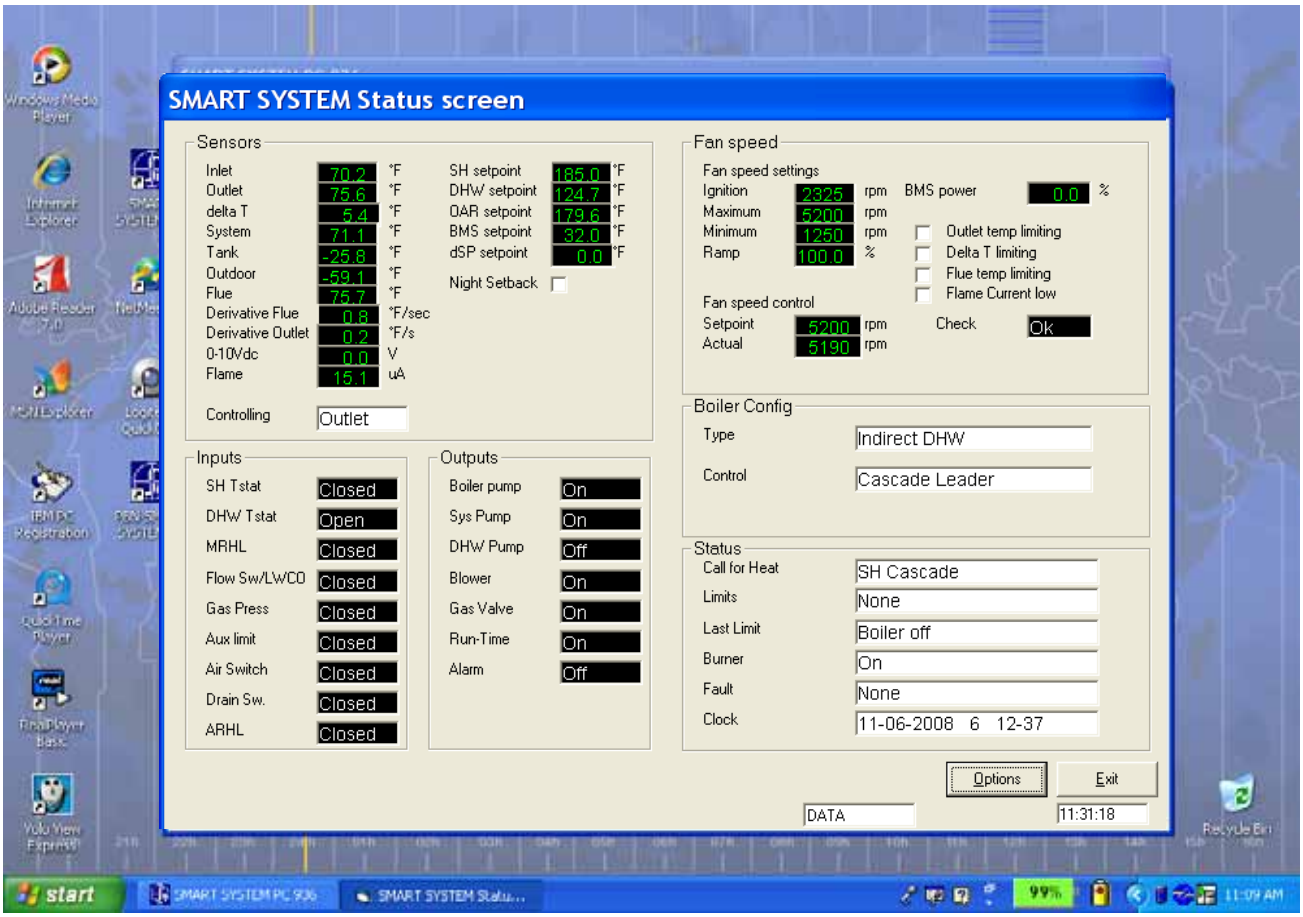
PC SOFTWARE

All of these features are built into the Smart System control on every model as standard equipment. But to help you see them better, Lochinvar offers PC Software. The PC software program can be downloaded onto a laptop computer and with the connection cable provided in the PC Software kit. You can connect to the PC port on the front of every Knight XL control panel.

PC Software Kit w/ USB Connector Cable, Owner's Kit - KIT30003
PC Software Kit w/ USB Connector Cable, Installer's Kit - KIT30006

SCREEN SHOT OF PC SOFTWARE



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Chapter 6 – Other Details of Great Importance

STANDARD CODES, STANDARD CONSTRUCTION
The Knight XL boiler is design certified to the latest edition of ANSI Z21.13. The third party certification was performed by CSA International and the boiler bears the American Blue Star emblem and the Canadian Blue Flame emblem. The heat exchanger inside the boiler conforms to the latest edition of the ASME Boiler and Pressure Vessel Code, Section IV and the vessel bears the ASME "H" Stamp.

The installation of a heating boiler is governed by local boiler codes. The boiler shall be installed in accordance with those installation regulations and shall be carefully followed in all cases. Authorities having jurisdiction shall be consulted before installations are made. The local code may require a feature on the boiler above and beyond the ANSI requirements. Check the list of factory installed options on page 33. Again, some of these options are factory installed and must be specified on the original purchase order. Review the local code especially in regard to the venting requirements.

In the absence of local codes, U.S. installations shall conform to the latest edition of the National Fuel Gas Code, ANSI Z223.1. In Canada, the installation must comply with the Canadian Gas Association Code, CAN/CGA-B149.1 and/or B149.2 and/or local codes.

Details

CSA International
Blue Star for United States

CSA International
Blue Flame for Canada

ASME, Section IV
"H" stamp for Boilers

OPTIONAL CODES, ADDITIONAL CONSTRUCTION
Many local authorities require the boiler installation conform to CSD-1, the American Society of Mechanical Engineers Safety Code for Controls and Safety Devices for Automatically Fired Boilers. CSD-1 is subject to different interpretation by different boiler inspection offices.
The Knight XL boiler must be factory trimmed to meet CSD-1 code to your specifications.

Factory Mutual is a popular insurance code and the Knight XL boiler must be factory trimmed to meet Factory Mutual. The well known Industrial Risk Insurers code has been purchased by General Electric Company and replaced with their own "GE Gap" code. For boilers under 2,500,000 Btu/hr, both Factory Mutual and GE Gap are met by being configured for CSD-1.
The Knight XL boiler must be factory trimmed to meet Factory Mutual or GE Gap.

STATE CODES, ADDITIONAL CONSTRUCTION
All states have their own boiler installation code, but some states have codes that require special equipment on the boiler itself. For example, California, Massachusetts, Minnesota and Kentucky have state codes that require additions to Lochinvar products. Check with your local Lochinvar sales office or Lochinvar Customer Service for details.

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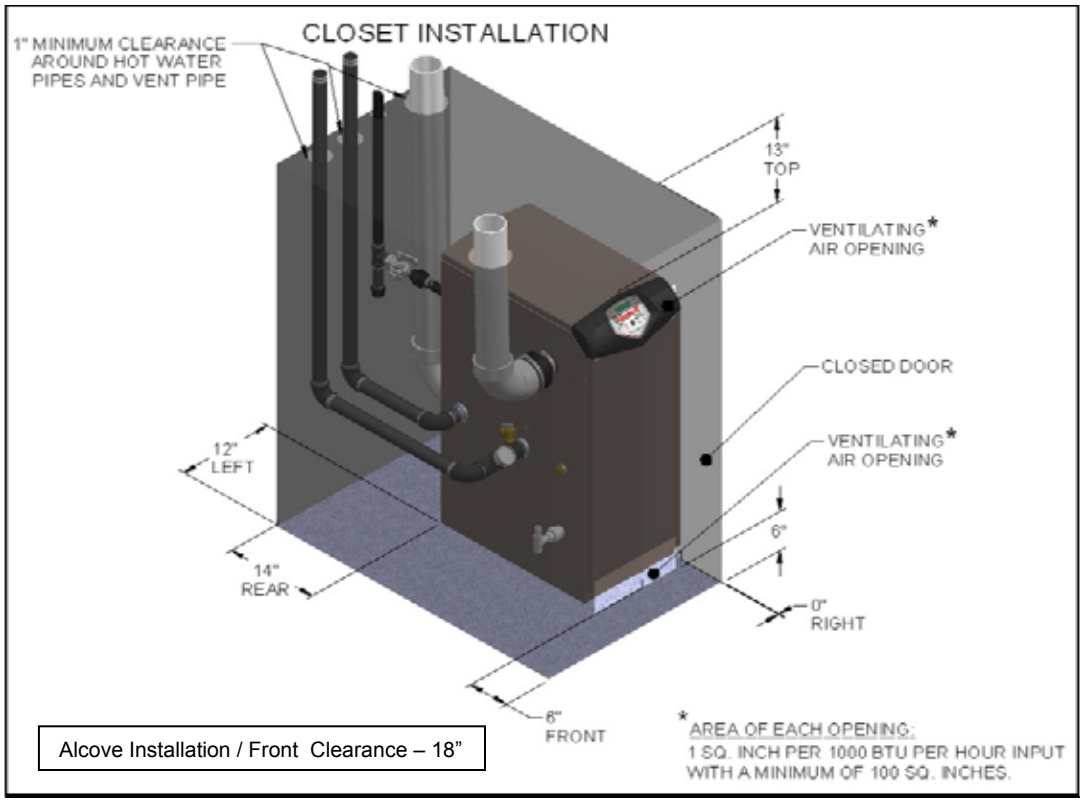
DETERMINE THE UNIT LOCATION

1. Locate the appliance so that if water connections should leak, water damage will not occur. When such locations cannot be avoided, it is recommended that a suitable drain pan, adequately drained, be installed under the unit. The pan must not restrict combustion airflow.
   Under no circumstances is the manufacturer to be held responsible for water damage in connection with this unit, or any of its components.
2. **DO NOT** install this appliance in any location where gasoline or flammable vapors are likely to be present.
3. The appliance must be installed on a level floor. Combustible floor locations may be used. Maintain required clearances from combustible surfaces.
4. The appliance must be installed indoors where it is protected from exposure to wind, rain, and weather.
5. This appliance may condense the products of combustion if operated at water temperatures below 140°F (60°C). Ensure that the appliance is located near an acceptable drain where condensate that may form in the venting system can be properly collected and disposed.
6. Access to the rear of the appliance MUST be maintained.


CLOSET INSTALLATION
1" MINIMUM CLEARANCE AROUND HOT WATER PIPES AND VENT PIPE
13" TOP
VENTILATING* AIR OPENING
CLOSED DOOR
VENTILATING* AIR OPENING
12" LEFT
14" REAR
6"
0" RIGHT
6" FRONT
* AREA OF EACH OPENING:
1 SQ. INCH PER 1000 BTU PER HOUR INPUT WITH A MINIMUM OF 100 SQ. INCHES.

Alcove Installation / Front Clearance – 18"

Recommended Service Clearances	
Front	30" (762 mm)
Top	24" (610 mm)
Left Side	24" (610 mm)
Rear	24" (610 mm)

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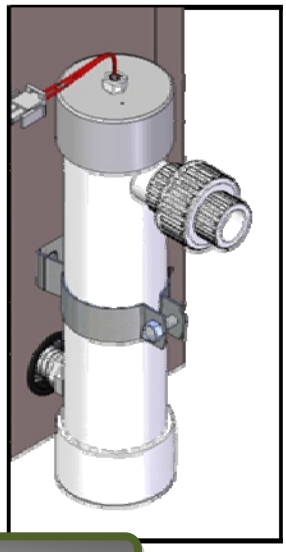
CONDENSATE TRAP
The Knight XL is fitted with a condensate trap to be field mounted onto the appliance. The trap is a requirement of the ANSI standard for any Category IV vented appliance with condensation forming in the stack.

If local code requires condensate neutralization, please order KIT3046, Neutralization Kit.



HIGH ALTITUDE APPLICATIONS
Atmospheric pressure decreases as the height above sea level increases. At any altitude above sea level, a cubic foot contains less gas than a cubic foot at sea level. Thus, the heating value of a cubic foot of fuel gas will decrease as height above sea level increases. Therefore a recalculation of heat input rate should be performed on any appliance beginning at 2000 feet. Ratings should be reduced at the rate of 4 percent for each 1000 feet above sea level.

Important

THE KNIGHT XL BOILER MUST BE FACTORY TRIMMED FOR INSTALLATIONS ABOVE 4500 FEET.

OPTIONAL EQUIPMENT
Lochinvar provides the following selection of optional equipment to meet your building requirements.

Alarm Bell – Field Installation Kit, KIT3085
Installed onto the back of the appliance and wired to the Alarm on Any Failure contacts. It will sound on any failure. A silencing switch is provided. Alarm on Any Failure contacts are standard on every Knight XL boiler for connection to a remote alarm bell or Building Management System.

High & Low Gas Pressure Switches with Manual Reset – Factory Installation Only
The switches are mounted inside the appliance. The High Gas Switch will interrupt the call for heat should high gas pressure be sensed in the gas line. The Low Gas Switch will interrupt the call for heat if the gas pressure supplied to the appliance is too low to achieve a safe burner flame. Both switches require manual reset to restart the appliance.
High and Low Gas Pressure Switches with Manual Reset are part of the Factory Mutual, GE Gap or CSD1 option packages.

Low Water Cut-Off, Probe Type with Manual Reset – Field Installation Kit, KIT3057
The electronic board is mounted in the control panel with a sensing probe mounted in the top header of the heat exchanger. The LWCO is set to interrupt the call for heat if a low water condition is sensed. The LWCO requires manual reset to restart the appliance. This is offered for many local codes that do not accept the standard-equipped flow switch as a low water cut off device. Check with local code authorities for acceptance of the standard flow switch as a low water cut off device.

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Appendix A

Boiler Piping Diagrams

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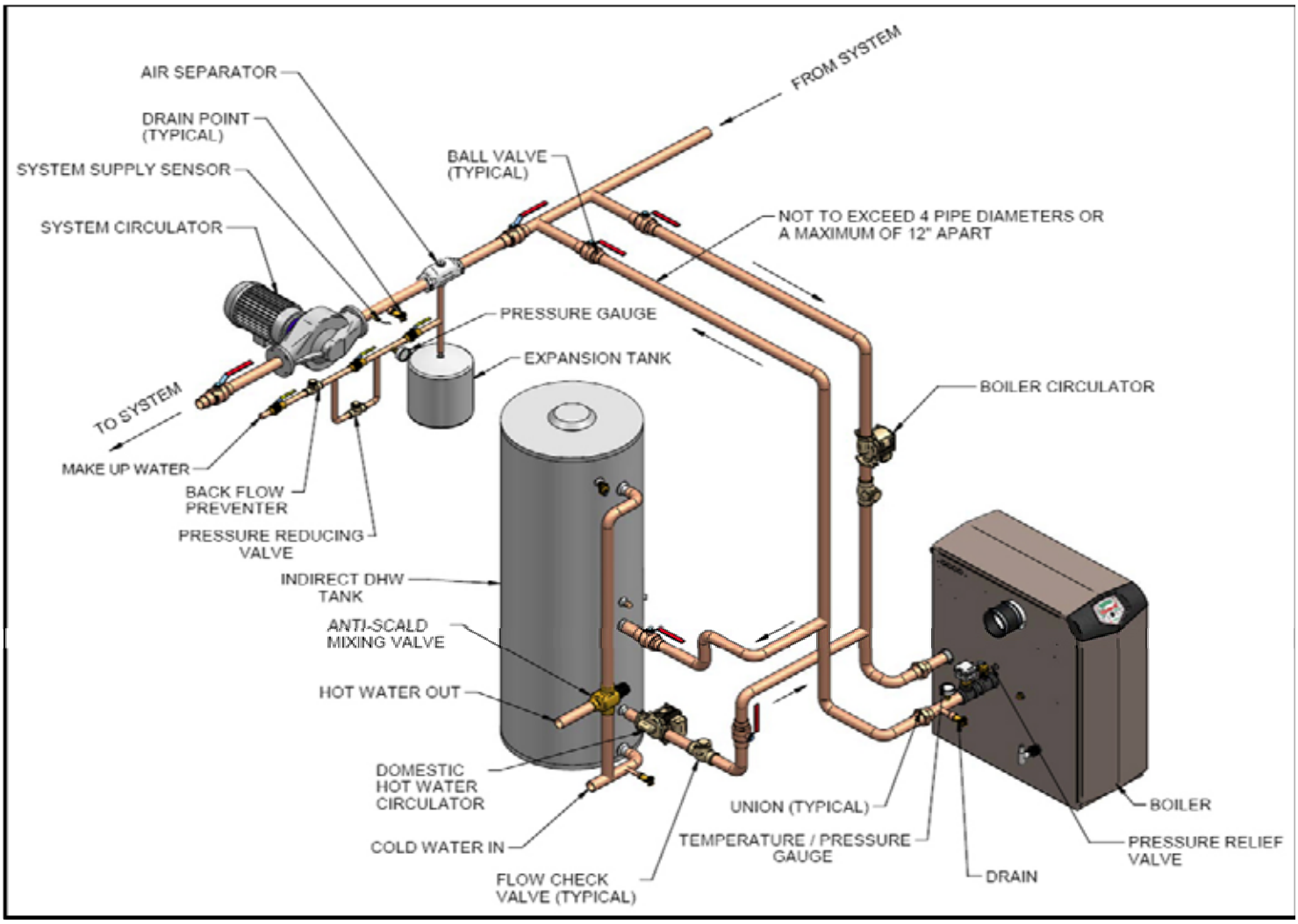
PAGE A1
PRIMARY/SECONDARY or SYSTEM/BOILER PIPING



The illustration is for concept only and should not be used for actual installation without engineering or technical advice from a licensed engineer. All necessary system equipment may not be illustrated.

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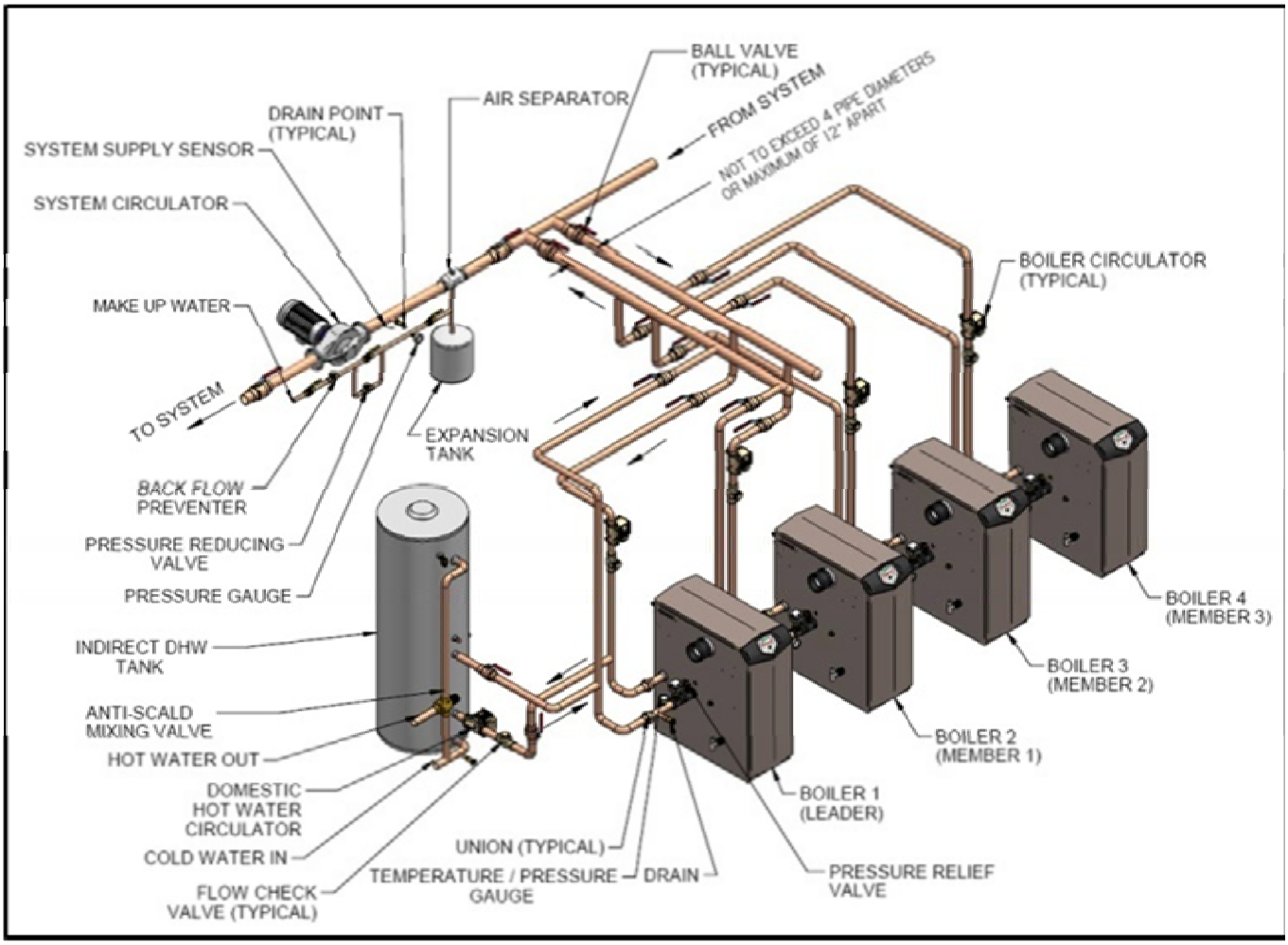
PAGE A2
MULTIPLE UNIT – PRIMARY/SECONDARY or SYSTEM/BOILER PIPING



The illustration is for concept only and should not be used for actual installation without engineering or technical advice from a licensed engineer. All necessary system equipment may not be illustrated.

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Appendix B

Technical Data
and
Boiler Component Breakdown

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Knight XL – the components, the design

1. Stainless steel heat exchanger
System water flows through specially designed coils for maximum heat transfer, while providing protection against flue gas corrosion. The coils are encased in a jacket that contains the combustion process.
2. Heat exchanger access cover
Allows access to the combustion side of the heat exchanger coils.
3. Blower
The blower pulls in air and gas through the venturi (item 5). Air and gas mix inside the blower and are pushed into the burner, where they burn inside the combustion chamber.
4. Gas valve
The gas valve senses the negative pressure created by the blower, allowing gas to flow only if the gas valve is powered and combustion air is flowing.
5. Venturi
The venturi controls air and gas flow into the burner.
6. Flue gas sensor
This sensor monitors the flue gas exit temperature. The control module will modulate and shut down the boiler if the flue gas temperature gets too hot. This protects the flue pipe from overheating.
7. Boiler outlet temperature sensor
This sensor monitors boiler outlet water temperature (system supply). If selected as the controlling sensor, the control module adjusts boiler firing rate so the outlet temperature is correct.
8. Boiler inlet temperature sensor
This sensor monitors return water temperature (system return). If selected as the controlling sensor, the control module adjusts the boiler firing rate so the inlet temperature is correct.
9. Temperature and pressure gauge (field installed, not shown)
Monitors the outlet temperature of the boiler as well as the system water pressure.
10. Electronic display
The electronic display consists of 7 buttons and a dual line 32-character liquid crystal display.
11. Flue pipe adapter
Allows for the connection of the PVC vent pipe system to the boiler.
12. Burner (not shown)
Made with metal fiber and stainless steel construction, the burner uses pre-mixed air and gas and provides a wide range of firing rates.
13. Water outlet (system supply)
A 1-1/2" or 2" NPT (depending on the model) water connection that supplies hot water to the system.
14. Water inlet (system return)
A 1-1/2" or 2" NPT (depending on the model) water connection that returns water from the system to the heat exchanger.
15. Gas connection pipe
1" NPT threaded pipe connection. This pipe should be connected to the incoming gas supply for the purpose of delivering gas to the boiler.
16. SMART Control Module
The SMART Control responds to internal and external signals and controls the blower, gas valve, and pumps to meet the heating demand.
17. Automatic air vent
Designed to remove trapped air from the heat exchanger coils.
18. Air intake adapter
Allows for the connection of the air intake pipe to the boiler.
19. High voltage junction box
The junction box contains the connection points for the line voltage power and all pumps.

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20. Boiler drain port
Location from which the heat exchanger can be drained.
21. Low voltage connection board
The connection board is used to connect external low voltage devices.
22. Low voltage wiring connections (knockouts)
Conduit connection points for the low voltage connection board.
23. Condensate drain connection
Connects the condensate drain line to a 1/2" PVC union.
24. Access cover - front
Provides access to the gas train and the heat exchanger.
25. Ignition electrode
Provides direct spark for igniting the burner.
26. Flame inspection window
The quartz glass window provides a view of the burner surface and flame.
27. Gas shutoff valve
Manual valve used to isolate the gas valve from the gas supply.
28. High limit
Device that monitors the outlet water temperature. If the temperature exceeds its setting, it will break the control circuit, shutting the boiler down.
29. Relief valve
Protects the heat exchanger from an over pressure condition. The relief valve will be set at 50 PSI.
30. Flame sensor
Used by the control module to detect the presence of burner flame.
31. Line voltage wiring connections (knockouts)
Conduit connection points for the high voltage junction box.
32. Top panel
Removable panel to gain access to the internal components.
33. Power switch
Turns 120 VAC ON/OFF to the boiler.
34. Leveling legs
Used to allow the heat exchanger to be leveled. This is needed for the proper draining of the condensate from the combustion chamber.
35. Air shroud (Model 501 only)
The air shroud controls air and gas flow into the burner.
36. Air pressure switch
The air pressure switch detects blocked flue/vent conditions.
37. Pump relay board
The pump relay board is used to connect the boiler, system and DHW pumps.

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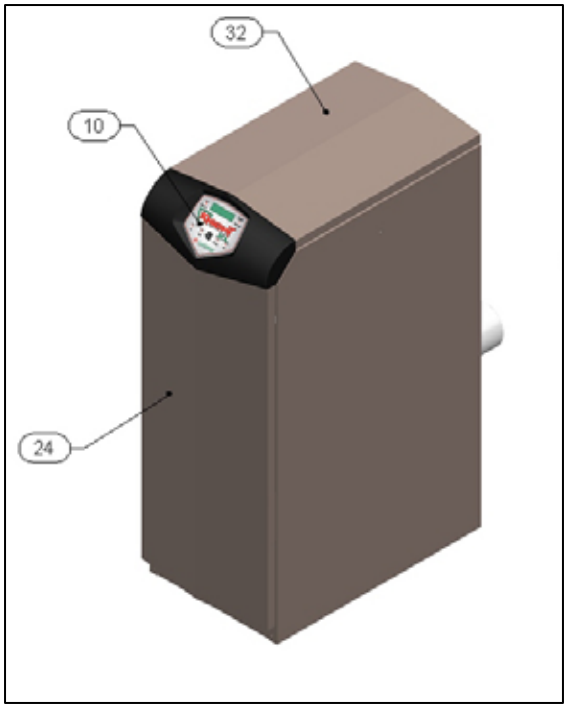
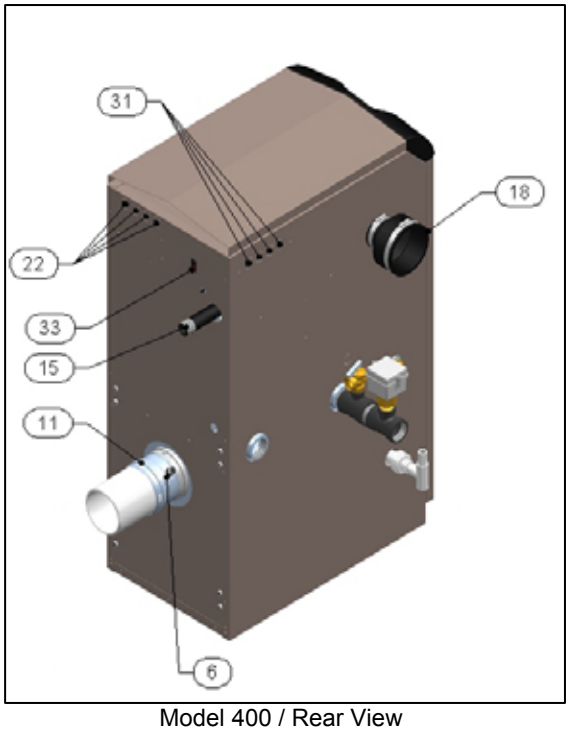
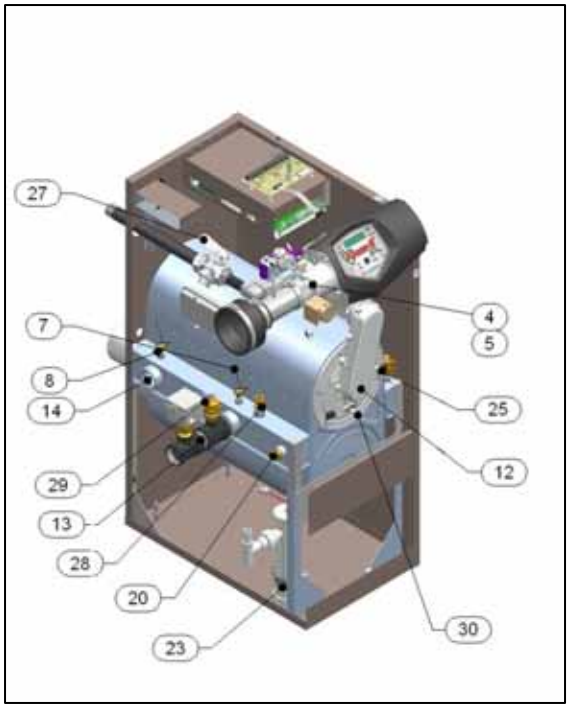
Knight XL 400 - 801



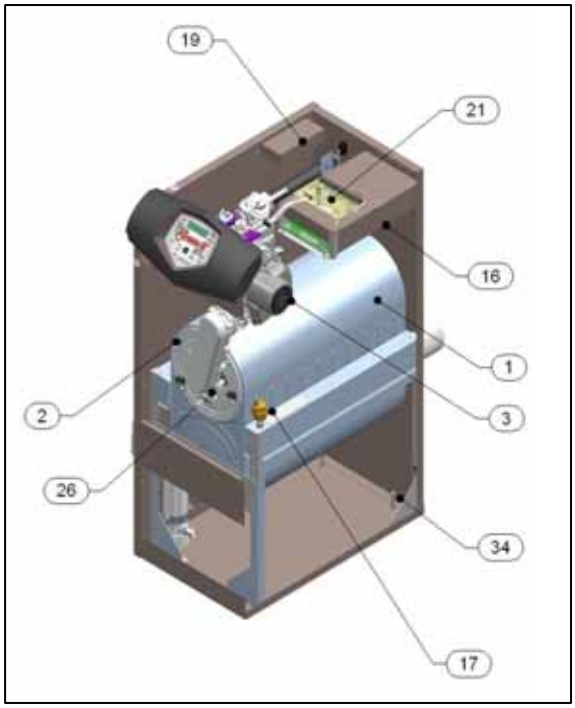
Model 400 / Front View



Model 400 / Rear View



Model 400 / Left Side (inside view)



Model 400 / Right Side (inside view)

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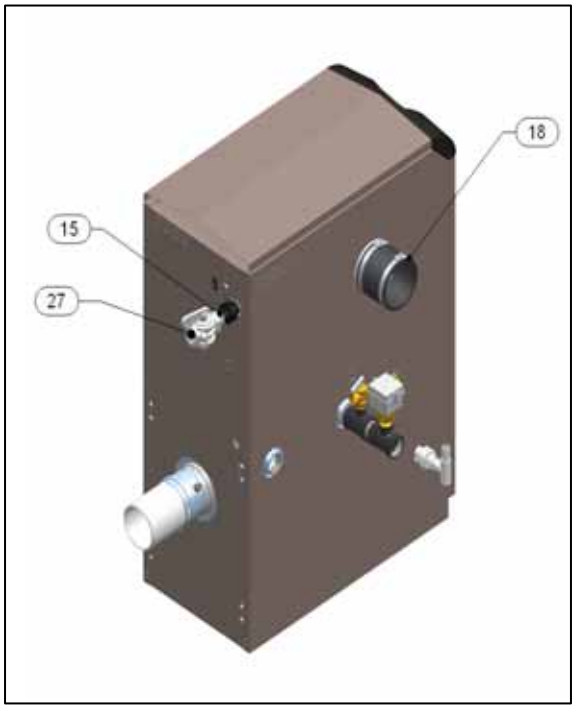
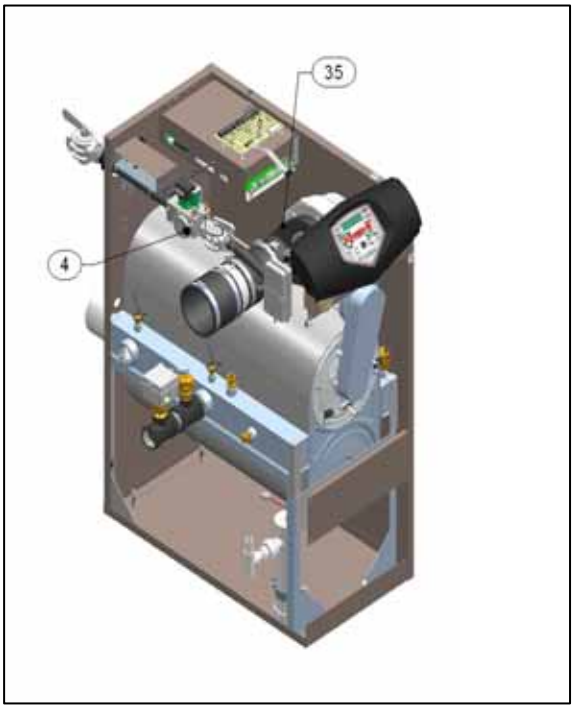
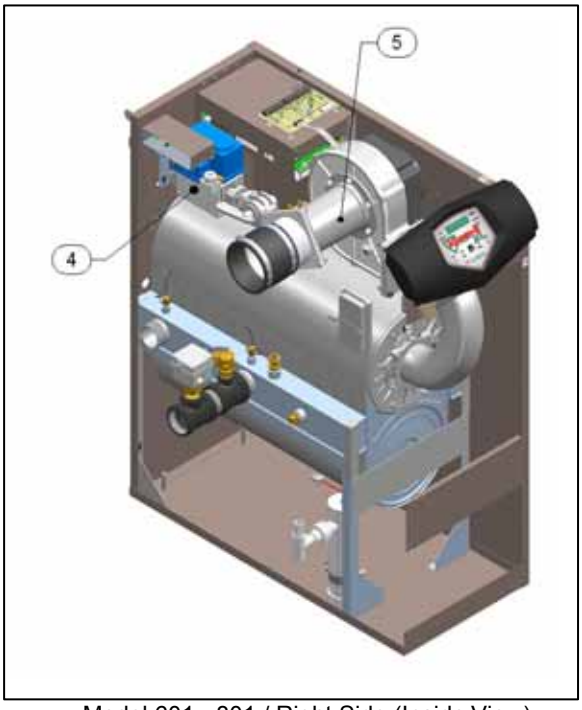


Model 501 / Rear View



Model 501 / Left Side (inside view)

Model 601 - 801 / Rear View



Model 601 - 801 / Right Side (Inside View)

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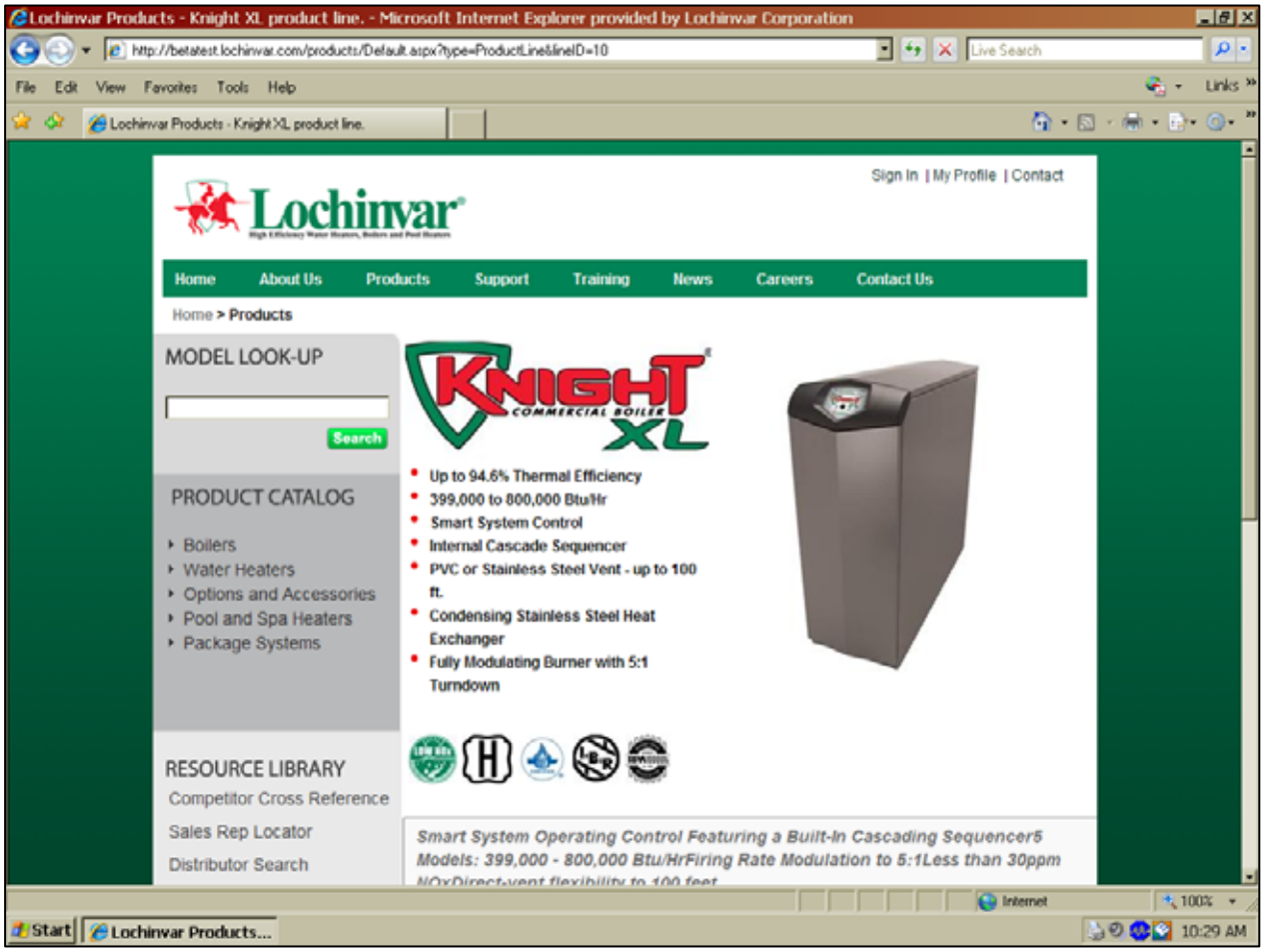
Go to www.lochinvar.com for more information on all Lochinvar products.

This is a screen shot of the Knight XL webpage. From the home page, click the "Products" button on the top tool bar. From the menu on the Products page, click "Boilers", then on the "Boilers" page, click "Commercial Boilers". Finally, click on "Knight XL".

In this Knight XL webpage, you will be able to download the Installation Manual, the Service Manual, the Knight XL Brochure, Piping Diagrams, Plan View Drawings and much more.



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